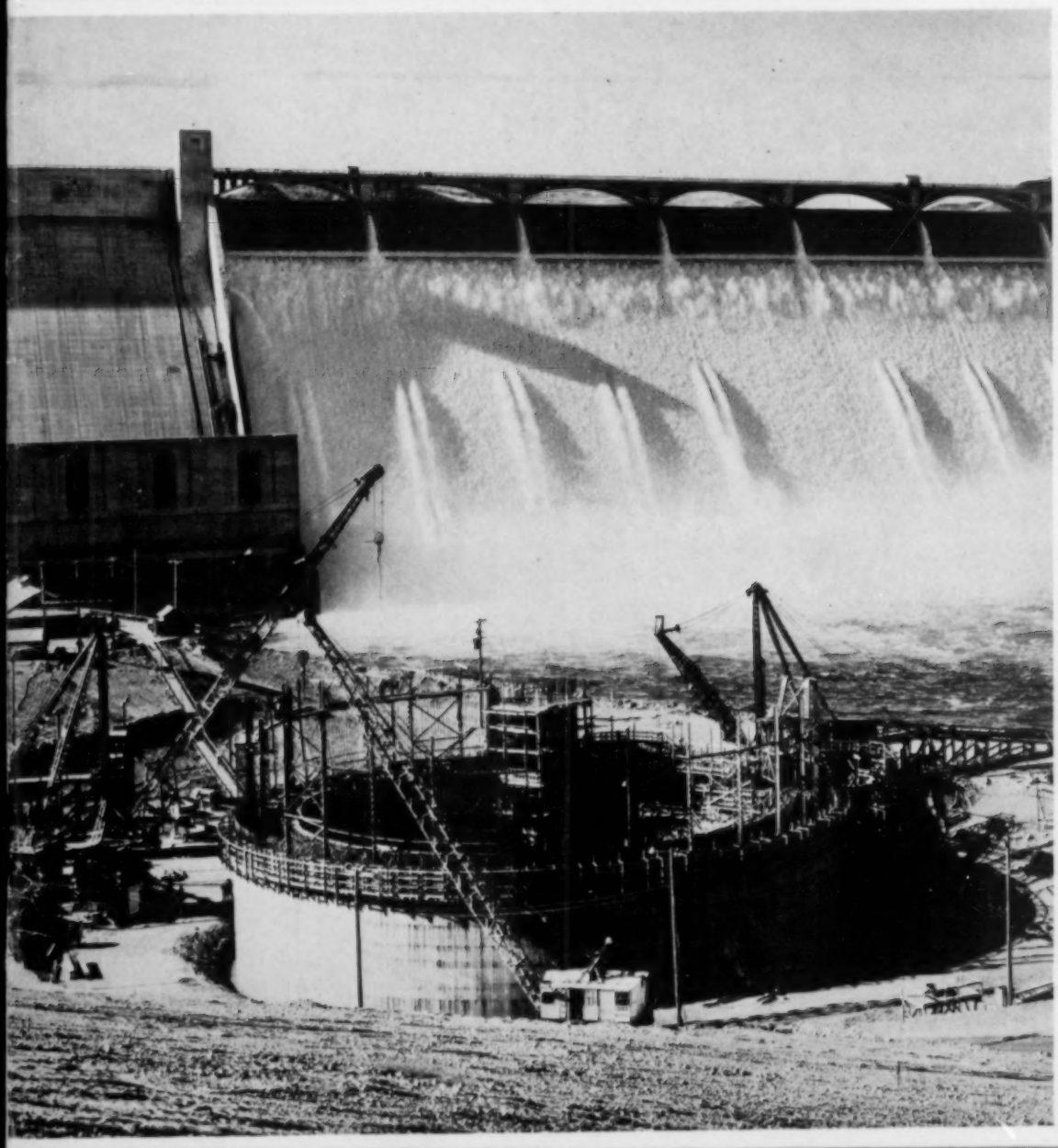
Compressed Air Magazine

MARCH 1945

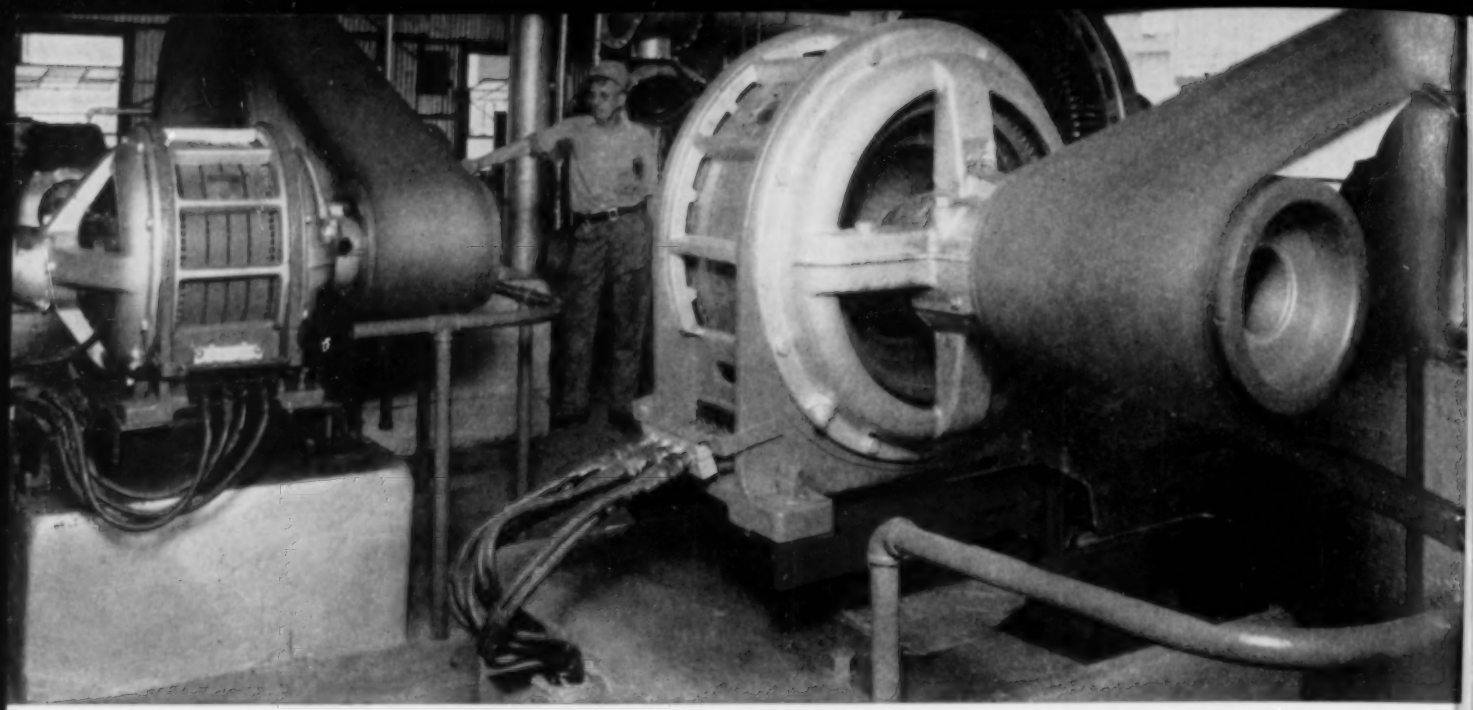


BUILDING GRAND COULEE DRY DOCK

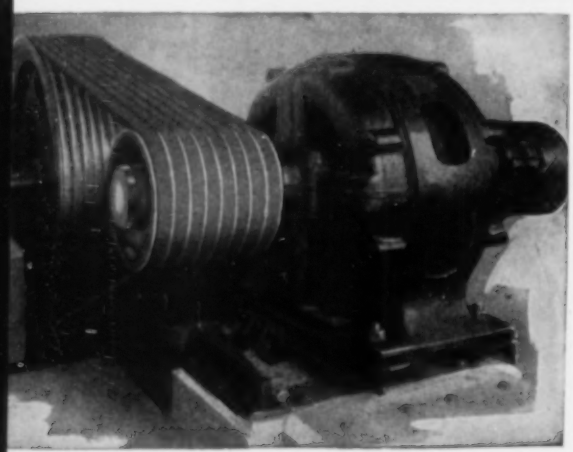
This structure will house a floating caisson for repairing eroded concrete

VOLUME 50 • NUMBER 3

NEW YORK • LONDON



ROCKWOOD *automatic* *belt tightening* MOTOR BASES



V-BELT DRIVES NEED ROCKWOOD MOTOR BASES

because V-belt drives slip at load peaks—increasingly so as grooves and belts wear in service. There is an amazing and immediate improvement when the motor is mounted on a Rockwood base and the belts kept tight to prevent belt slip.

If there is any data you desire—or any questions you want to ask—we will be glad to hear from you. The Rockwood dealer near you carries a stock of Rockwood bases—along with his stocks of Rockwood V-belts, V-sheaves and Rockwood paper pulleys.

Rockwood are the world's largest manufacturers of pulleys —with 1,447 stock sizes ready to ship. Their stocks of V-belts and V-belt sheaves are enormous—even today With 7,889 stock sizes of V-sheaves—and every size and length of V-belts. A large percentage of which is ready for immediate delivery.

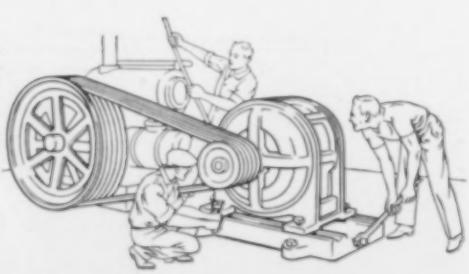
Compressor motors mounted on Rockwood Bases produce more air and at lower overall costs

With flat belts or V-belts the Rockwood automatic belt tightening motor base assures maximum compressor performance—WITHOUT INTERRUPTIONS—WITHOUT BELT TROUBLE. By keeping the belt tightness adjusted automatically to match the load COMPRESSOR CAPACITIES ARE INCREASED.

No longer will the belts slip and the compressor slow down at peak loads. Gone are the worries about belt wear and breakage. With Rockwood motor base the belts will have nearly double their former life. Drive maintenance will be eliminated. The Rockwood motor base becomes your maintenance man.

YOU DO NOT HAVE TO WAIT UNTIL YOU BUY A NEW COMPRESSOR TO INSTALL A ROCKWODD DRIVE. You can install one under ANY compressor belt drive motor you now have—use the same belts—Rockwood bases are available—up to 60 h.p. from stock—up to 250 h.p. (semi stock) delivered with reasonable promptness—still larger sizes prices and delivery quoted on request.

Costly shut downs for manual belt tightening are a thing of the past—too wasteful of time and labor. Thanks to the Rockwood pivoted motor base belt tightening is now made automatic. Belts that stretch are automatically re-tightened—and neither too tight nor too loose—but just right to suit the varying load. Considered the biggest improvement ever developed for electric motor belt drives. For use with either V-belts or flat belts.

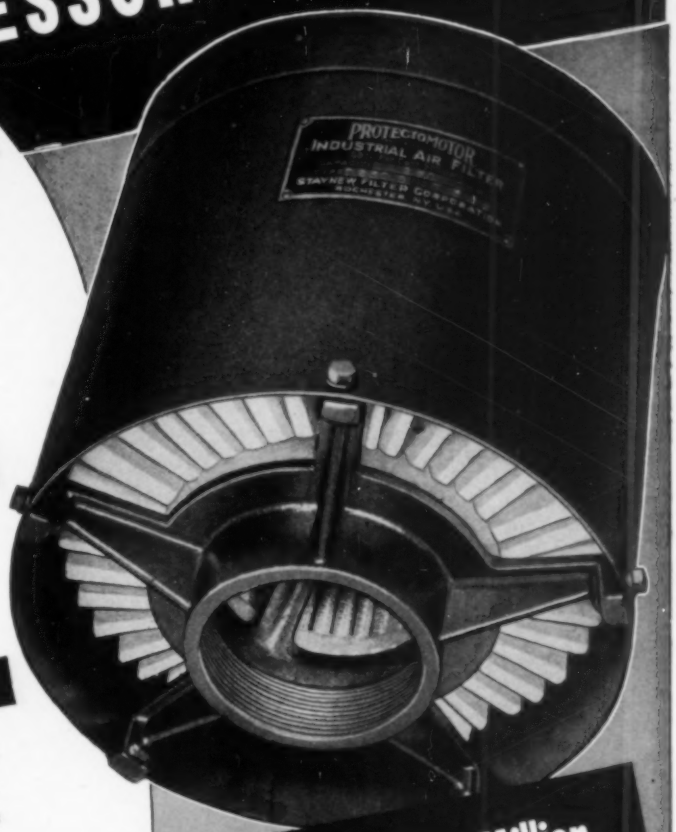


ROCKWOOD

INDIANAPOLIS • U. S. A.

Specialists in Power Transmission Equipment Since 1884

WHY PROTECTOMOTOR INTAKE FILTERS ARE BEST FOR AIR COMPRESSOR USE



★ HIGH EFFICIENCY WHEN INSTALLED

Protectomotor Air Filters for internal combustion engines and compressors feature dry-type filtering media. These media are selected to fit particular installation conditions. They have been scientifically tested in the laboratory and proven by field use. Used in combination with the patented Radial Fin Insert Construction, they provide highest operating efficiency.

★ INCREASED EFFICIENCY WITH USE

Protectomotor filtering efficiency actually *increases* when dust begins to accumulate on the surface of the media, since this forms a precoating or filter-aid of the very material which is being handled.

★ LOW RESTRICTION TO AIR FLOW

Protectomotors at maximum ratings offer initial resistance to air flow of less than ½" of water. Since the exclusive Radial Fin Construction provides a maximum of filtering area, this resistance is held to a minimum throughout the life of the filter.

★ SERVICING SELDOM NECESSARY

The Protectomotor is a masterpiece of simple, rugged construction. There are no moving parts, no reservoirs, no liquids. The extremely large active filtering area reduces cleaning to an absolute minimum for any given set of conditions. When required, cleaning is quickly and easily accomplished by vacuum, compressed air, or washing.

★ POSITIVE PROTECTION ★ ★ ★

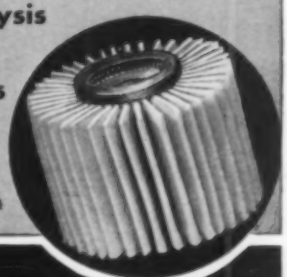
Inherent characteristics of the dry-type filtering media provide *positive* protection. Performance is *not* dependent upon periodic renewal of viscous coatings or other filter aids. Ideal for dust storm areas.

★ EFFICIENT AT HIGH OR LOW TEMPERATURES

As the filtering media used are of the dry-type, peak efficiency is maintained under all atmospheric conditions. There is no oil to evaporate at high temperatures or to congeal at low temperatures.

More than Half a Million Installations on Internal Combustion Engines and Compressors since 1920

Write for Catalog and Data Blank for Free Analysis of your Requirements



Radial Fin Construction

STAYNEW for PROTECTOMOTOR FILTERS

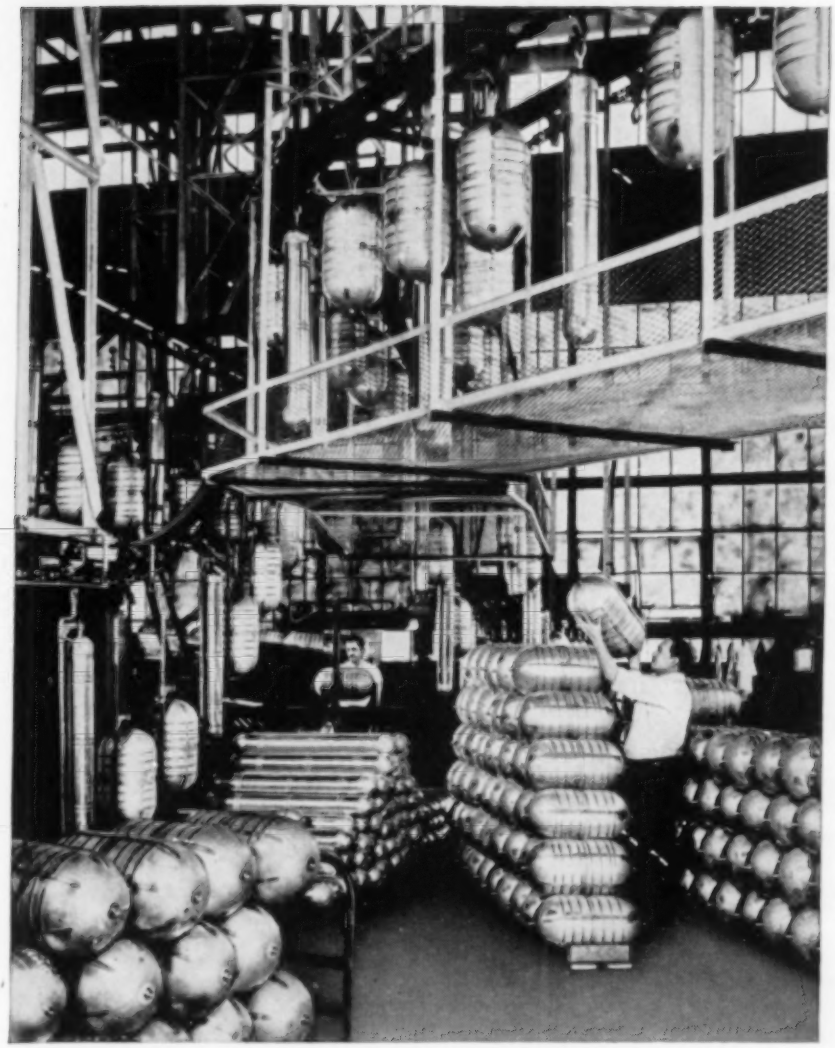
DOLLINGER CORPORATION
(Formerly Staynew Filter Corp.)
7 Centre Pk., Rochester 4, N. Y.

Laurels by the Yard

Just as vital to winning the war—though less dramatic than the war-front achievements of Bucyrus-Erie excavators—is the steady, high-production performance they deliver at home. With their "years ahead" reputation and their ability to handle both stripping and loading at lowest cost per yard, the Bucyrus-Eries at home are winning war laurels too — helping quarry and mine operators maintain the high speed output that's so important today!

V-78

SO. MILWAUKEE **BUCYRUS ERIE** WISCONSIN



FOUND

A way to eliminate danger of oxygen cylinder explosions

A BULLET piercing an ordinary oxygen tank normally causes a devastating explosion—a deadly menace to fliers on combat missions. Now, for the first time, stainless steel cylinders have been developed that will withstand even cannon fire without exploding. These are the type being used in B-29 Superfortresses.

Whether used to fill oxygen tanks, power air tools, or provide compressed air for countless other industrial jobs, compressors run more efficiently, with less down time, when lubricated effectively. For this reason, operators everywhere use Texaco.

Texaco Alcaid, Algol or *Ursa Oils* in compressors, for instance, assure wide-opening, tight-shutting valves, free piston rings, open ports, clear lines, continuous air supply. They also assure maximum service life between overhauls, fewer repairs and replacements. Their use in compressors is world-wide.

Texaco lubricants have proved so effective in service they are definitely preferred in many fields, a few of which are listed at the right.

Texaco Lubrication Engineering Service is available to you through more than 2300 Texaco distributing points in the 48 States. The Texas Company, 135 East 42nd Street, New York 17, N. Y.

THEY PREFER TEXACO

★ More buses, more bus lines and more bus-miles are lubricated with Texaco than with any other brand.

★ More stationary Diesel horsepower in the U. S. is lubricated with Texaco than with any other brand.

★ More Diesel horsepower on streamlined trains in the U. S. is lubricated with Texaco than with all other brands combined.

★ More locomotives and railroad cars in the U. S. are lubricated with Texaco than with any other brand.

★ More revenue airline miles in the U. S. are flown with Texaco than with any other brand.

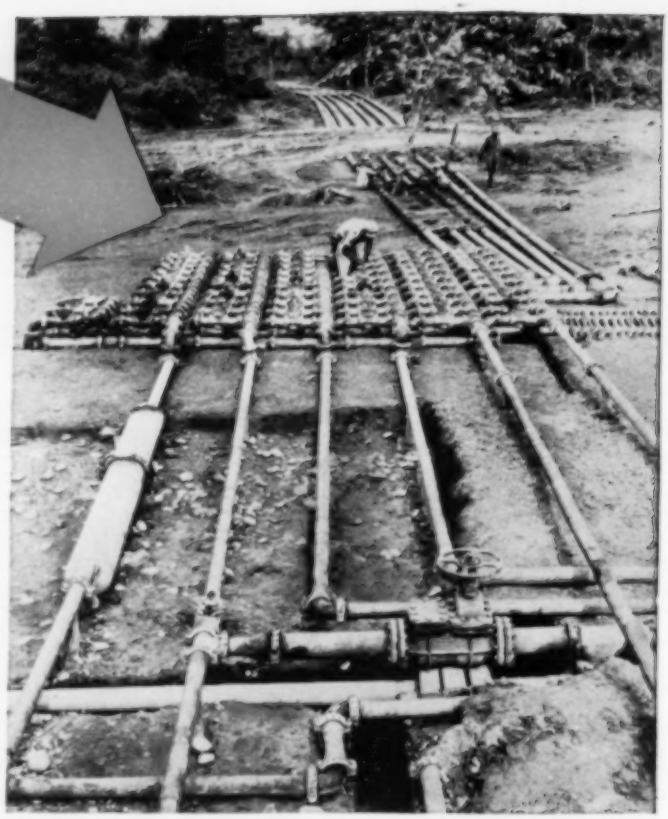
TEXACO

TEXACO Lubricants

FOR ALL COMPRESSORS AND AIR TOOLS

TUNE IN THE TEXACO STAR THEATRE WITH JAMES MELTON SUNDAY NIGHTS ★ METROPOLITAN OPERA BROADCASTS SATURDAY AFTERNOONS

WORLD'S LONGEST PIPELINE — Part of a 2000-mile line from India to China. Laid through some of the worst terrain in all the world, this line is subjected to every imaginable strain . . . It is coupled by Victaulic.



WAR BONDS
A PIPE LINE FROM YOU TO HIM

The terrific job of "fueling" our armies overseas does not end when the tankers unload at the ports. Too little known is the amazing story of the thousands of miles of Army pipelines that are laid at top-speed, often under fire — and must be able to withstand extreme strains of terrain and battle conditions. Millions of Victaulic couplings have been used on these Army pipelines — for these two special reasons . . . their speed and ease of assembly . . . their ability to provide a flexible, leak-tight joint, and to go on providing it under even the worst conditions.

THROUGH JUNGLE RIVERS the fast-working 775th Army Engineers lay part of the 2000-mile vital pipeline. Despite the constant pressure of powerful river currents Victaulic couplings insure lock-tight, leak-proof joints.

SO THAT YOU can find out more about these Couplings, get the color-illustrated Victaulic Catalog and Engineering Manual. No obligation — simply drop us a line on your company letterhead. Write to: VICTAULIC COMPANY OF AMERICA, 30 Rockefeller Plaza, New York 20, N. Y. Other Victaulic offices — Victaulic Inc., 727 West 7th St., Los Angeles 14, Cal.; Victaulic Co. of Canada, Ltd., 200 Bay St., Toronto.

VICTAULIC

Reg. U. S. Pat. Off.

SELF-ALIGNING PIPE COUPLINGS AND FULL-FLOW FITTINGS

OIL MINING MARINE MUNICIPAL INDUSTRIAL

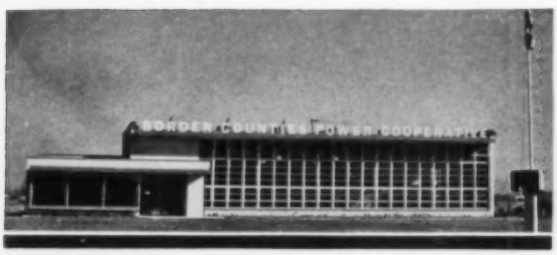
Copyright 1945 by Victaulic Co. of America

HOW TO PUT WASTE HEAT TO WORK

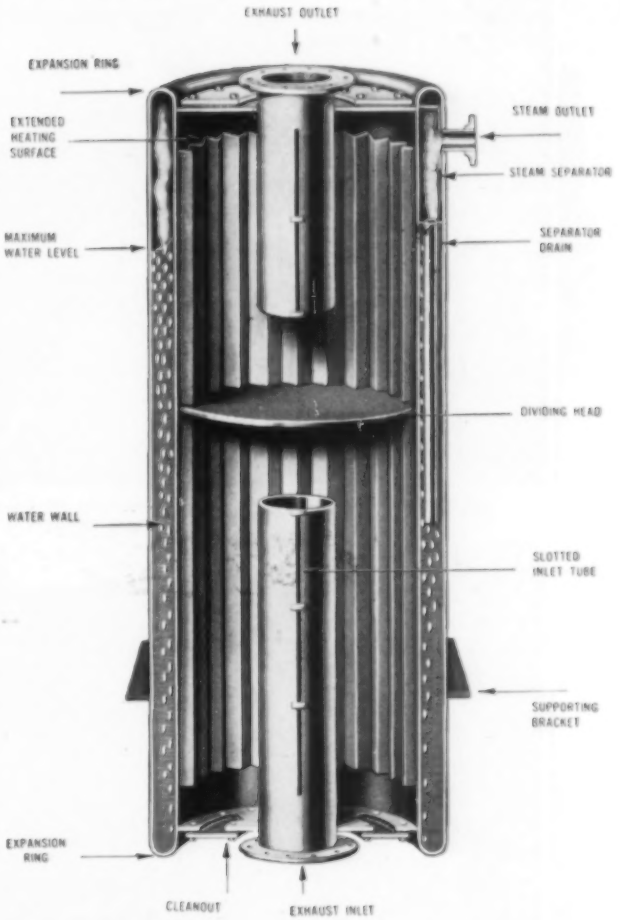
WITH MAXIM HEAT RECOVERY SILENCERS

Engine exhaust heat, all too often wasted, can be put to good and profitable use through Maxim Heat Recovery Silencers. With these specially constructed silencers extra steam or hot water for heating or processing operations is obtained *without extra fuel cost* as the heat source is simply engine exhaust heat. Thus in one unit effective exhaust silencing, spark arresting (where necessary) and heat recovery are combined for maximum operating efficiency. Such a saving, important to your balance sheet at any time, is doubly important where fuel supplies are difficult to obtain.

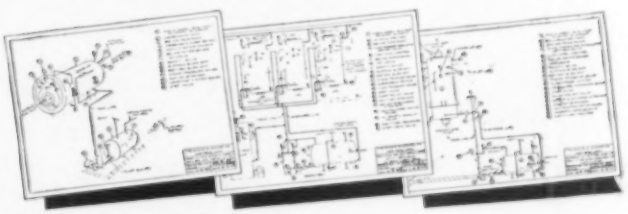
The power plant below located in northern Minnesota is heated entirely through the use of Maxim Heat Recovery Silencers.



For silencing, without the heat recovery feature, Maxim makes silencers for internal combustion engine exhaust or intake, steam engine exhaust, air compressor intake, vacuum pump discharge, blower intake and discharge, high velocity steam, air or gas discharge. Engine exhaust silencers available with or without spark arrestor. Bulletins on request.



PRACTICAL WORKING HOOK-UPS



The Maxim Engineering Department has prepared several drawings of typical Heat Recovery Silencer hook-ups. These are available with a detailed discussion of each hook-up. We will be glad to send them to you. Just ask for Dwgs. B-298, B-301, B-302 and B-303.

ARMY E NAVY

MAXIM

THE MAXIM SILENCER CO. • 85 HOMESTEAD AVE., HARTFORD, CONN.

The ORIGINAL *and* MOST OUTSTANDING

With the Navy Seabees.

Supplying air for salvage work at Pearl Harbor.

Operating Jackhamers on the ALCAN Highway.

A powerful drilling combination (K-500 plus two FM-2 wagon drills) heading for the next job.

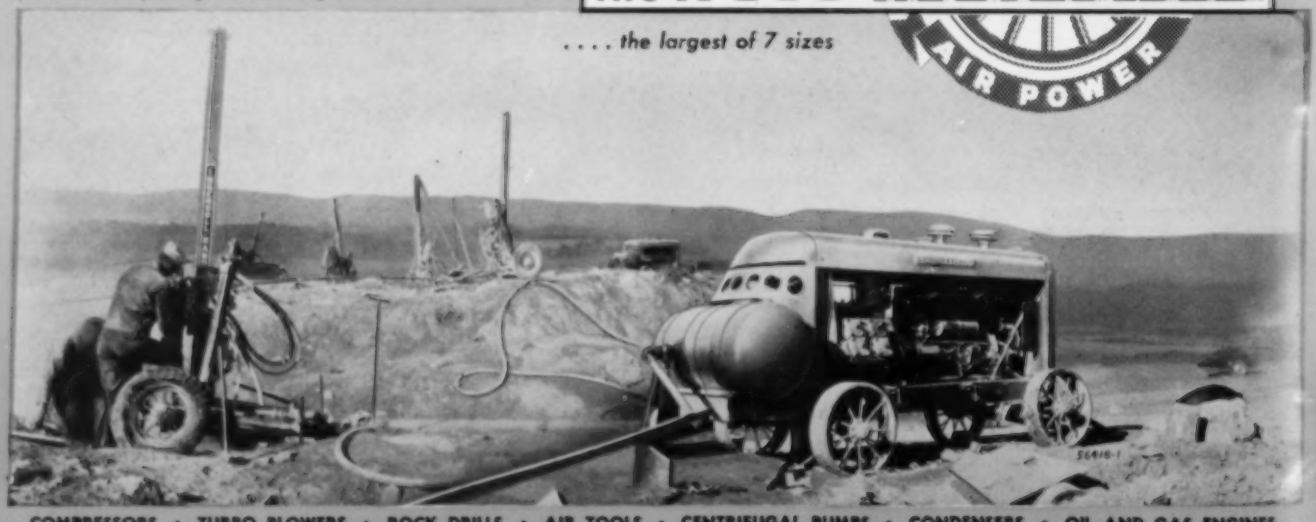
1939 on the Pennsylvania Turnpike ... two of the first K-500 compressors, each operating two FM-2 wagon drills.

Ingersoll-Rand

The K-500 MOBIL-AIR

AIR POWER

. . . . the largest of 7 sizes

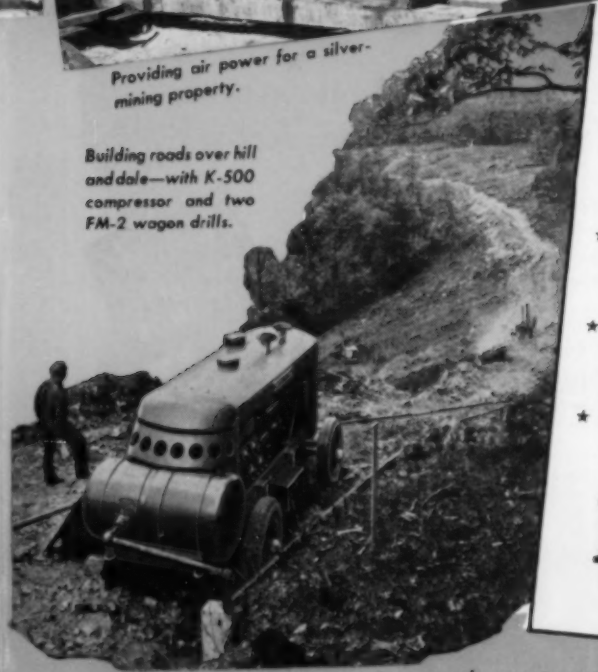


COMPRESSORS • TURBO BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

500 CUBIC-FOOT PORTABLE COMPRESSOR

Helping to build the TVA power development.

Providing air power for a silver-mining property.



Building roads over hill and dale—with K-500 compressor and two FM-2 wagon drills.

Although other 500-cfm portable compressors have been developed since Ingersoll-Rand introduced the K-500 MOBIL-AIR in 1939, there is none with the background of performance of this machine. There are more K-500s in actual operation in all parts of the world than all other portable compressors of this capacity.

Here are the reasons for this outstanding success:

1 It's the only 500-cfm portable available with a gasoline engine as well as an oil engine. (See ★ below).

2 Weighs only 10,600 pounds . . . the lightest 500-cfm machine available.

3 Big enough to run two powerful FM-2 wagon drills.

4 Small enough and tough enough to go trail-blazing over mountains and through swamps.

5 Drill-More multi-speed regulator makes the machine even more efficient at half load than at full load. When running only one wagon drill or lighter drills, no more fuel is required than if a smaller compressor were used.

6 Multi-speed regulation of portable-compressor capacity was originated by Ingersoll-Rand . . . introduced with the K-500. The average working speed of compressor and engine is lower . . . more efficient . . . less wear . . . longer life.

7 Spring mounting and automotive-type steering are standard.

8 Electric cranking with commercial 12-volt equipment is standard for oil as well as gasoline engine. Both engines are easily hand-cranked.

9 "Finger-tip" control of heavy-duty, easily maintained clutch.

10 All operating controls and gauges are centrally controlled.

11 Low, easily filled fuel tank.

12 Proven design, performance, stamina, and reliability . . . used all over the world.

★ 13 Quickly convertible from operation on one fuel to another (oil, gasoline, or natural gas) by substituting external fuel accessories only.

★ 14 Astonishingly low gasoline consumption presents a new consideration in the choice between oil and gasoline drive.

★ 15 For oil, it's the well-known I-R Type H engine . . . smooth running, easy to maintain, easy to start.

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

2-497

We also make the tools that use the compressed air

STRENGTH

FOR SAFETY AND LONG-TIME SERVICE

Specify

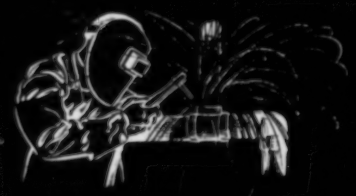
Vogt

DROP FORGED STEEL FITTINGS

SCREW END TYPE

For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SOCKET WELD TYPE



For schedules 40, 80 and 160 pipe — Sizes 1/8" to 6"

Round-the-clock operation of oil refineries, chemical plants, steam plants, etc., essential to the continuous flow of war products to the United Nations, is all in the day's work for these fittings. Today, as in peacetime, Vogt drop forged steel fittings make a major contribution to the efficient functioning of pipe lines in plants vital to the war effort.

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled matorials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy.

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

HENRY VOGT MACHINE CO., Inc., LOUISVILLE 10, KY.

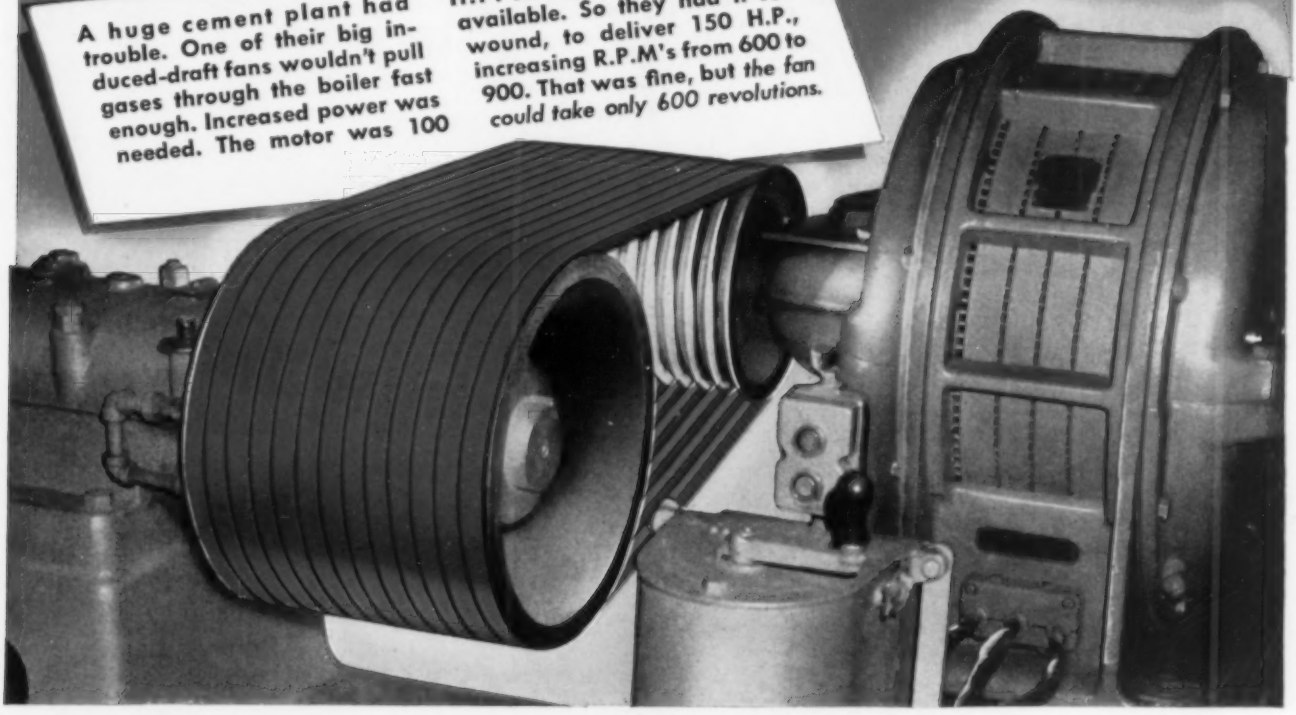
BRANCH OFFICES: NEW YORK • PHILADELPHIA • CLEVELAND • CHICAGO • DALLAS

DAYTON V-BELT DISTRIBUTOR

CREATES *Unusual* SOLUTION OF

INDUCED-DRAFT FAN PROBLEM

A huge cement plant had trouble. One of their big induced-draft fans wouldn't pull gases through the boiler fast enough. Increased power was needed. The motor was 100 H.P. A bigger one wasn't available. So they had it rewound, to deliver 150 H.P., increasing R.P.M's from 600 to 900. That was fine, but the fan could take only 600 revolutions.



—So they called their Dayton V-Belt Distributor

He and a Dayton factory man supplied 13 Dayton V-Belts and installed them so as to cut the R.P.M's for the fan back to 600, still delivering from the faster running motor *more* than the increased H. P. required. The problem dissolved. That was 6 years ago. Their Dayton V-Belts have continued to drive smoothly ever since... without attention or maintenance, without trouble whatsoever!

You can easily get the same efficient help to improve your power-transmission drives. You simply call the Dayton V-Belt Distributor. He will help you quickly convert to Dayton V-Belts that are smooth-running, hard-gripping, and especially long-lasting.

Dayton Rubber's Technical Excellence gives you V-Belts which are pronounced as unsurpassed in mechanically correct design and in their quality of construction. Your Dayton V-Belt Distributor will save you money.

V-Belts by Dayton Rubber

REG. TRADE MARK THE DAYTON RUBBER MFG. CO.

The Mark Of Technical Excellence In Synthetic Rubber

CALL YOUR DAYTON V-BELT DISTRIBUTOR OR WRITE DIRECT

THE DAYTON RUBBER MFG. CO.

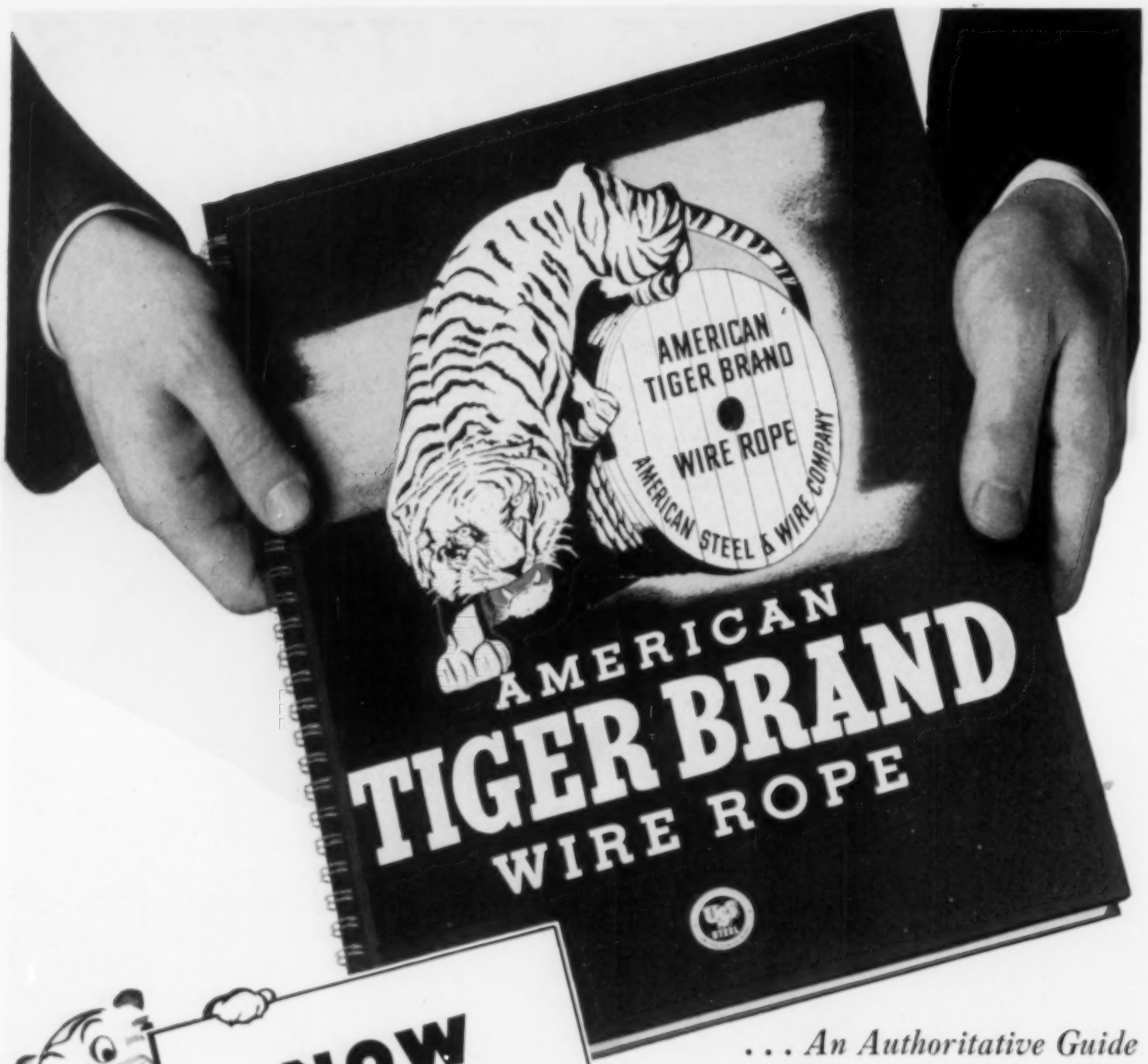
The World's Largest Manufacturer of V-Belts

DAYTON 1, OHIO

Dayton Rubber Export Corporation, 38 Pearl Street, New York, N. Y., U. S. A.

Cable Address: WIDBLOCO

KEEP ON BUYING WAR BONDS



. . . An Authoritative Guide on Its Selection, Use and Care

JUST off the press—AMERICAN TIGER BRAND'S new catalog—125 pages crammed with illustrations, specifications and descriptive material to help you select the wire rope that's exactly right for your particular job. In addition, special chapters feature modern methods of splicing, socketing, lubrication, and other facts essential to the proper use and care of wire rope in every field.

This catalog covers the complete range of both AMERICAN TIGER BRAND Excellay Preformed and AMERICAN TIGER BRAND Standard Non-Preformed Wire Rope and accessories.

This valuable book, with its quick-reference indexed pages should be in the hands of every man who buys or uses wire rope. A request on your letterhead will receive prompt attention.

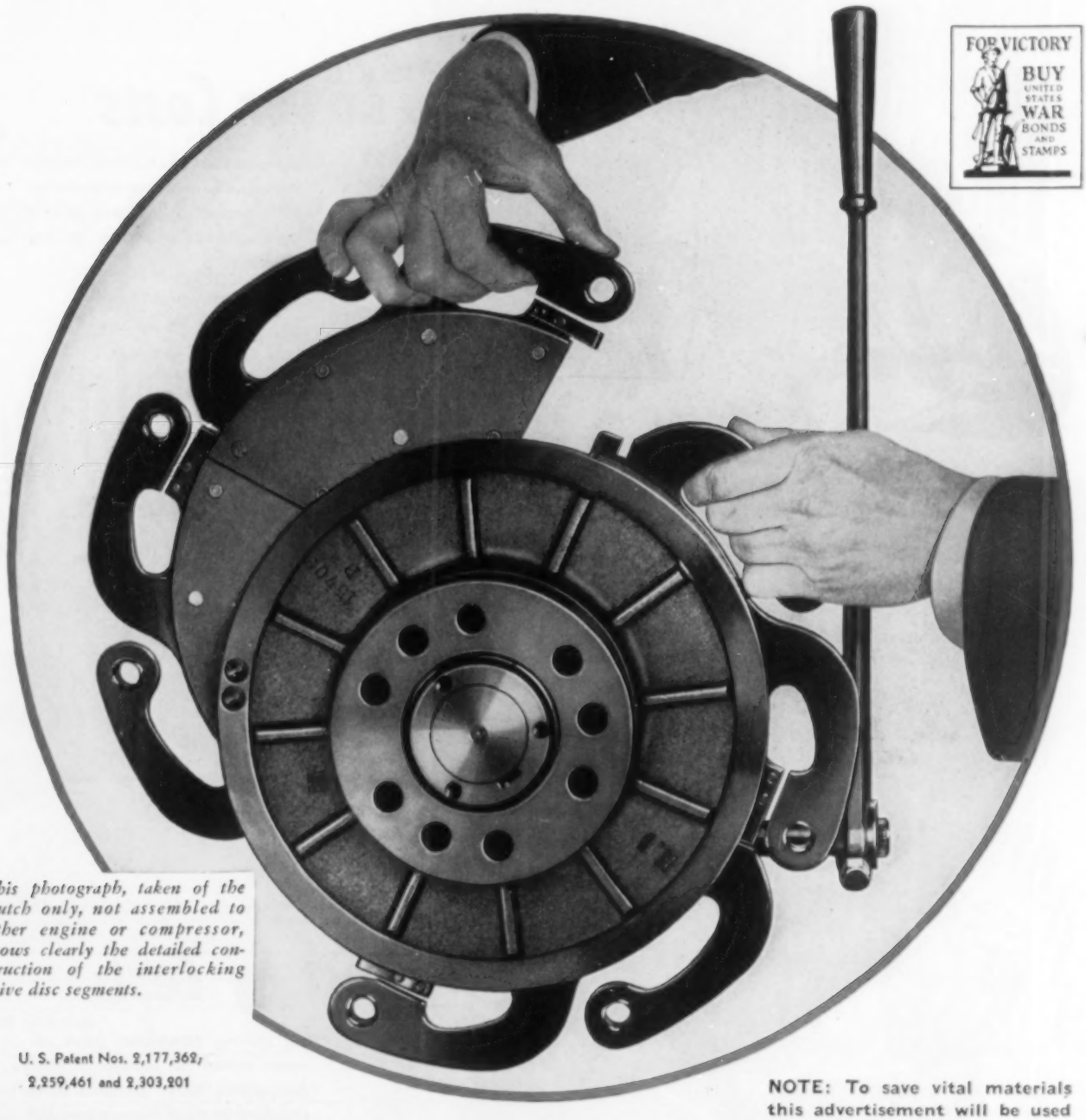
AMERICAN STEEL & WIRE COMPANY
Cleveland, Chicago and New York
COLUMBIA STEEL COMPANY
San Francisco
United States Steel Export Company, New York

USS STEEL

UNITED STATES STEEL

FLEX-DISC CLUTCHES

Used on the entire line of I-R *Mobil-Air* Compressors, have a time proven drive disc with flexible fingers solidly bolted to the fly wheel. When the friction facings become worn these drive discs, which are quickly detachable in segments, may be removed and relined or replaced without disconnecting the engine from the compressor.



FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

This photograph, taken of the clutch only, not assembled to either engine or compressor, shows clearly the detailed construction of the interlocking drive disc segments.

U. S. Patent Nos. 2,177,362; 2,259,461 and 2,303,201

NOTE: To save vital materials this advertisement will be used for "the duration."

C. M. EASON, INDUSTRIAL CLUTCH CO.

Waukesha Wisconsin

If You Knew What We Know—

Loading costs are down since we standardized on Eimcos.

Lower Costs

are possible when using RockerShovels. Maintenance drops below a fraction of a cent per ton and loading costs will drop proportionately.

Get us Eimcos—I'll get results.

Higher Tonnage

is the result of simple design, ease of operation, faster loading and dependability. Yes! increase your production with RockerShovels.

Don't experiment Son, use Eimcos.

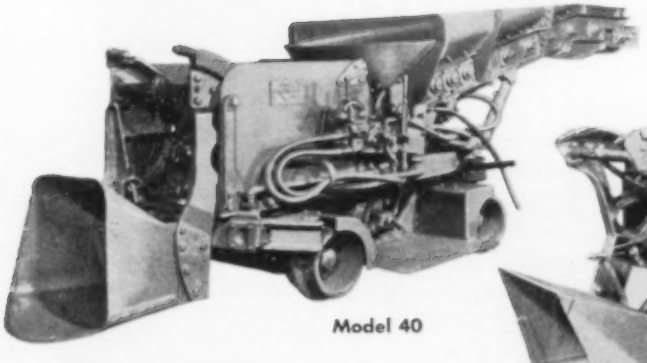
Best by Test:

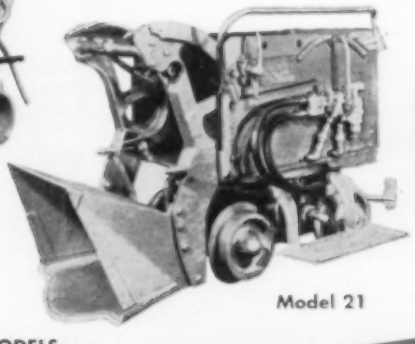
big mining companies have already tested all loaders in fair competitive tests. Eimco is now standard in all of these mines. Let us prove this fact to you.

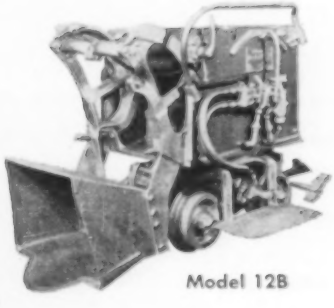
You, too, would insist on *RockerShovels* for all underground loading

Because we all agree they are:

Easier to run.
Have higher capacity.
Use less air.
Have much lower maintenance and outstanding dependability.


Model 40


Model 21


Model 12B

GENERAL SPECIFICATIONS UNDERGROUND MODELS

Models	12-B	21	40
Track gauge	15" to 36"	18" to 48"	30" to 56½"
Weight	4200	7300	15900
Maximum clean-up range	95"	115"	14 ft.
Maximum height of car above rail can be loaded	60"	66"	72"
Headroom range above rail	70" - 83"	85" - 94"	90" - 94"
Power	air only	air-elect	air-elect
Operating pressures	50 to 125 lbs.		

NOTE—Height, length and track gauge of your car determine head room and clean up.

Each Model of the Eimco RockerShovel has many combinations and can be altered in many ways to fit borderline cases not considered in the general specifications.

Eimco RockerShovel

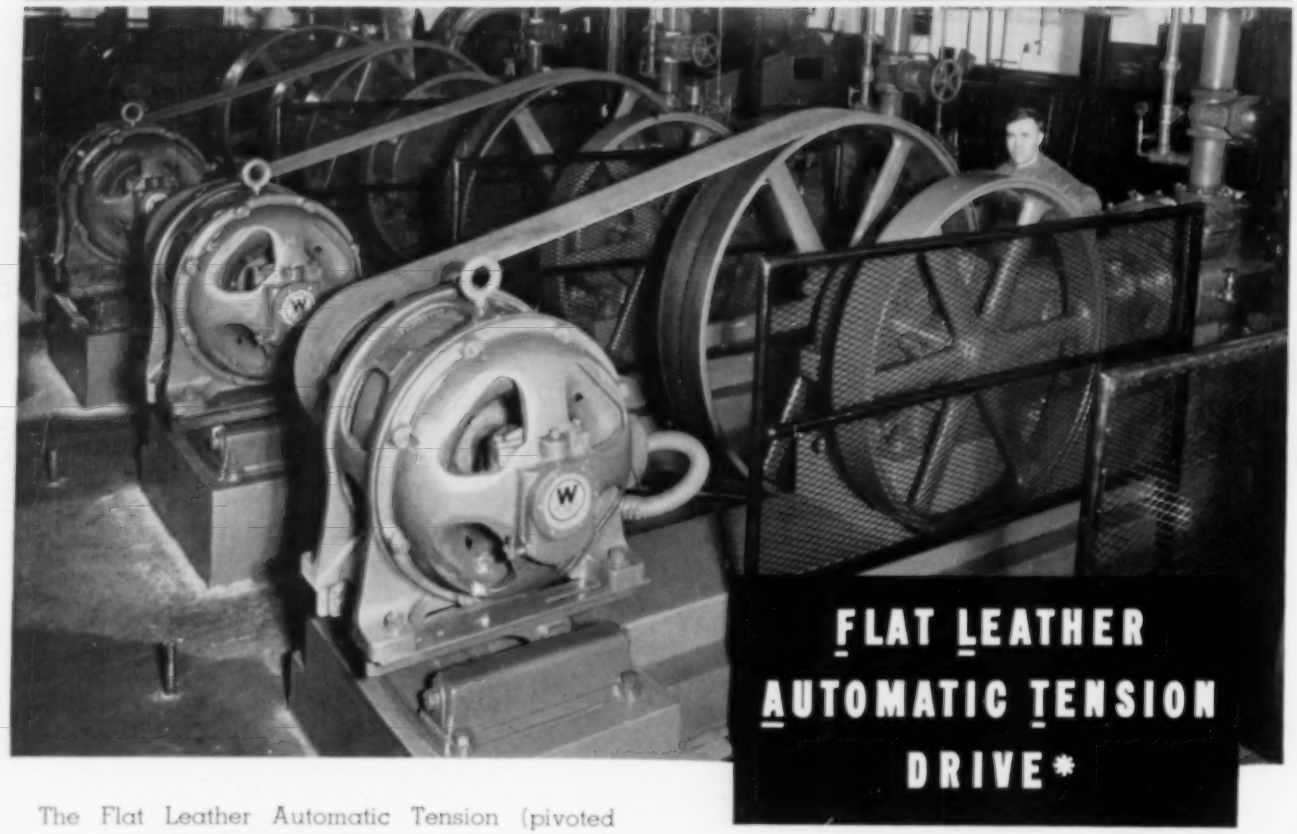
EIMCO

THE EIMCO CORPORATION

Executive Offices and Factories: Salt Lake City 8, Utah
Branches: New York, Chicago, El Paso, Sacramento, St. Louis

A86

THIS DRIVE CALLS FOR *Research*



The Flat Leather Automatic Tension (pivoted base) drive is your logical choice for driving compressors. The pivoted base maintains proper belt tension. When the load is light, belt tension is relaxed; when the load is heavy, the belt tension is **automatically** adjusted.

This drive, using Graton & Knight "Research" belting, meets the requirements of compressor drives because it adjusts itself to high inertia starting loads, cut-in and cut-out operating conditions and pulsating loads.

* Drive illustrated: Compressor, 8 x 12; motor, 15 hp, 860 RPM; motor pulley, 10"; compressor pulley, 42"; center distance, 56"; base, Rockwood #8; belt, 6" Research Double, G & K #7.

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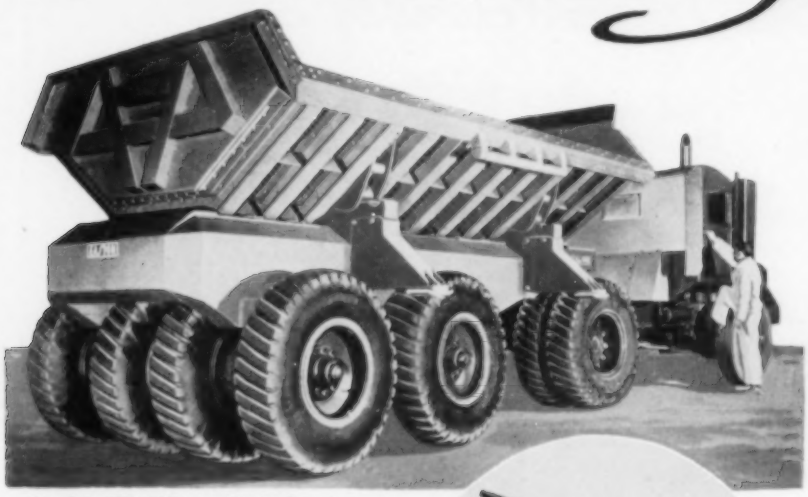
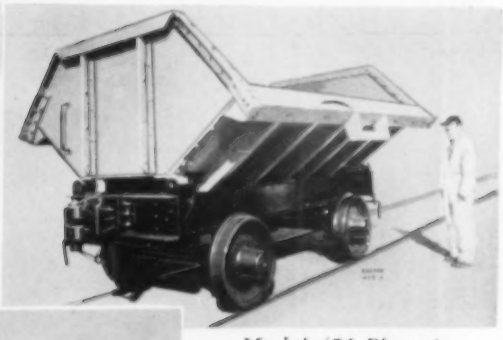


Model TR-15T trailerized mine car, eight oscillating wheels, side dumping

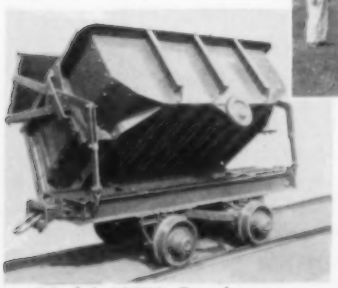
Model TG-710 trailerized mine car, automatic down fold door

Model BB-1830 truck body, overhead hoist



Model 472 Phoenix car, either side dump

Model TR-15D trailerized mine car, two Phoenix bodies



Model 12772 Granby car, dumps in transit

Model 16030 Alpha car, bale lift skip

Model 19608 Cornwall car, floor-mounted air hoist

Model TR-13H trailerized mine car, hydraulic dump

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ON THE COVER

WHEN engineers of the U.S. Bureau of Reclamation decided to build a floating caisson for use in gaining access to and repairing the bucket of Grand Coulee Dam, they were faced with the necessity of providing a suitable place in which to house the structure during the periods when it was not in service. Their answer was a cylindrical reinforced-concrete dry dock that has been constructed on the east bank of the Columbia River and just downstream of the dam. It has an inside diameter of 160 feet. The caisson is being built inside of it and will be floated out through a gate and drawn to the foot of the spillway by means of cables powered by winches. For additional details read the article starting on page 74.

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IN THIS ISSUE

THE old underground magnetite-iron-ore mines of New York, New Jersey, and Pennsylvania are regaining a measure of the prestige they lost when the supposedly inexhaustible hematite deposits of the Lake Superior District were developed by open-pit methods in the 1880's. War's insatiable appetite for steel has aided their comeback. The oldest of them all, the Mount Hope Mine near Dover, N. J., has been rehabilitated by an extensive modernization program that is described in our first article.

•

AN article about color should be illustrated in color, and we have splurged a bit in our treatment of *Color is Power*, which starts on page 79.

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A THREE-page article, telling how naval craft were built in Denver, Colo., 1300 miles inland, and miscellaneous short material round out the issue.

Compressed Air Magazine

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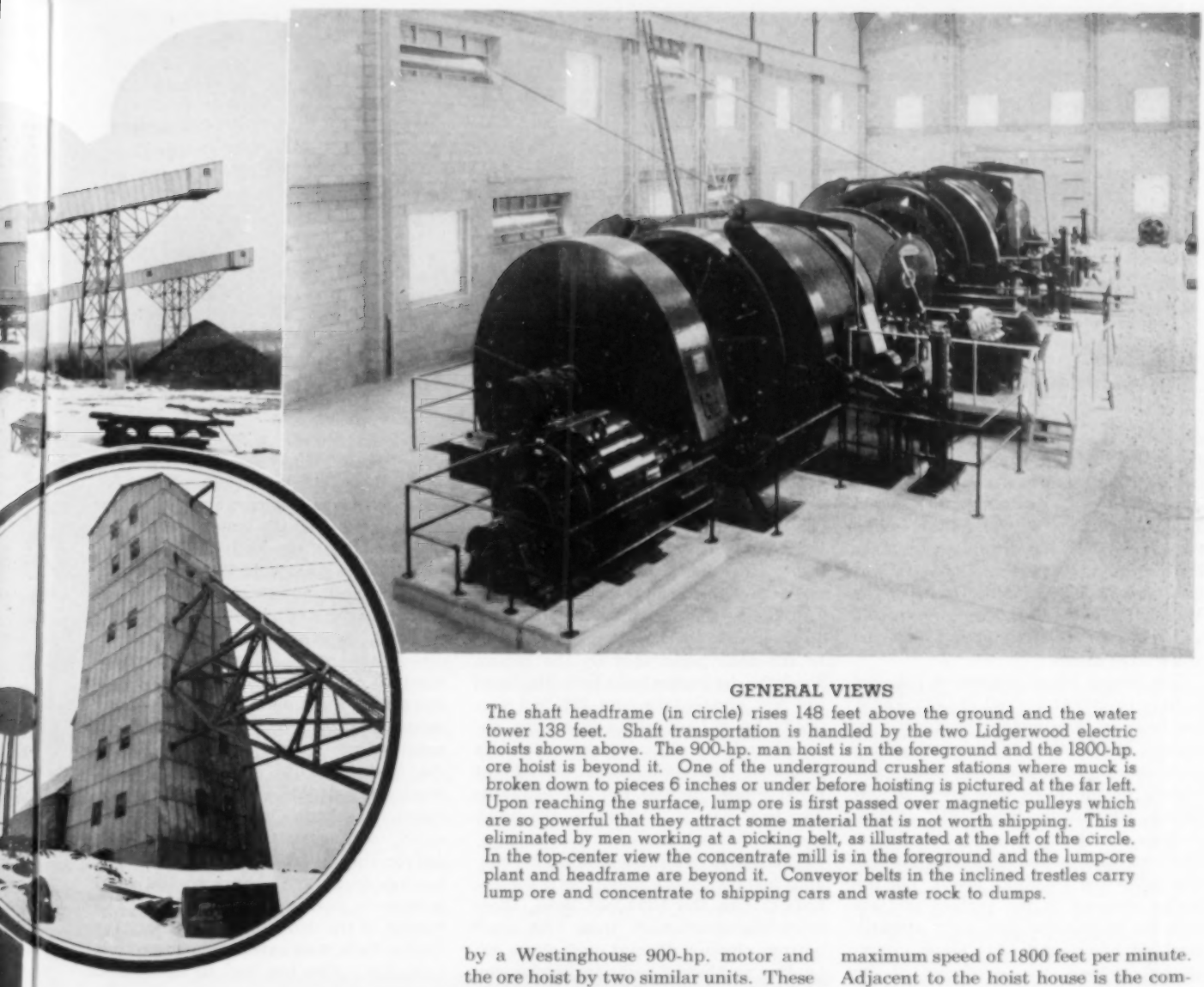
Mount Hope Mine Expands

C. H. Vivian

AN EXTENSIVE improvement program has recently been completed by the Warren Foundry & Pipe Corporation at its Mount Hope iron mine, situated near Dover, N. J., within an hour's ride of New York City and reputed to be the oldest operating mine in the nation. The new facilities include a deep shaft, two electric-driven hoists to serve it, a modern lump-ore treatment plant and fine-ore concentrating mill, a water-supply system, a change house for miners, and a heating plant. Underground, new pumps have been provided, new crushing plants built, additional electrical and haulage equipment installed, and considerable development work done to gain access to the ore bodies. The improvements will enable the mine greatly to increase production, reduce unit costs, and increase the grade of its products. Further, by providing access to deeper portions of ore bodies now being mined as well as to additional deposits previously not within economical reach, they will insure many years of output.

The program was initiated in 1941 in response to a request by the War Production Board for increased iron production. The Mount Hope Mine is one of the few properties that yield magnetite, and the particular virtue of its ore is that a large proportion of it is obtained in lump form, which is much in demand for use in open-hearth steel furnaces. The only other magnetite producers in the country are three more in New Jersey, a group in the Adirondacks of New York State, one in eastern Pennsylvania, and another at the eastern end of the Mesabi Range in Minnesota.

The current improvements were financed by the Warren Foundry & Pipe Corporation through a $4,000,000 loan, against which it issued 10-year sinking-fund notes. The engineering for the new surface facilities and the shaft was done by the J. G. White Engineering Corporation of New York. The mining company's own staff planned the underground work other than shaft sinking. It was originally hoped that the project could be finished in nineteen months from the starting date, but the manpower shortage delayed construction, especially of the shaft, and all units of the program were not ready for operation until the early part of this year. The fine-ore mill, however, has been in service since January, 1944, its completion having been rushed because of a fire in June of 1943 that destroyed the plant formerly in use. During the remainder of 1943, fine ore brought up



GENERAL VIEWS

The shaft headframe (in circle) rises 148 feet above the ground and the water tower 138 feet. Shaft transportation is handled by the two Lidgerwood electric hoists shown above. The 900-hp. man hoist is in the foreground and the 1800-hp. ore hoist is beyond it. One of the underground crusher stations where muck is broken down to pieces 6 inches or under before hoisting is pictured at the far left. Upon reaching the surface, lump ore is first passed over magnetic pulleys which are so powerful that they attract some material that is not worth shipping. This is eliminated by men working at a picking belt, as illustrated at the left of the circle. In the top-center view the concentrate mill is in the foreground and the lump-ore plant and headframe are beyond it. Conveyor belts in the inclined trestles carry lump ore and concentrate to shipping cars and waste rock to dumps.

through the existing Brown Shaft was stockpiled, and after the new plant was put in operation that material was transported to it for processing. The new mill also handled the fine ore produced through the Brown Shaft during 1944.

As revamped, the plant is designed to produce and treat 3000 tons of crude ore per day, or more than four times the maximum output obtainable with the older facilities. When the underground development work now underway is finished there will be five horizontal haulageways instead of one. These will be at the previously existing 1000-foot level and at the 1700-, 2100-, 2300-, and 2500-foot levels. All will provide means of access to several different ore bodies, and the two lower ones will make it possible to reach parts of the veins that have not been worked.

The hoisting equipment consists of two Nordberg units—one for a double-deck man-and-materials cage capable of transporting 60 men at a time, and the other for operating counterbalanced 10-ton ore skips. The man hoist is driven by a Westinghouse 900-hp. motor and the ore hoist by two similar units. These are of the direct-current type, and motor-generator sets are furnished to convert the incoming power-line alternating current for their use. One of these sets is made up of a 2000-hp. synchronous motor driving two 750-kw. generators and the other has an 800-hp. motor and one 750-kw. generator. The man hoist has a single, divided 12-foot drum the cable on one side of which is attached to the cage and that on the other to a 14-ton counterweight that runs in one of the shaft compartments. The ore hoist has two 14-foot drums. Each of the four hoist drums is wound with 3400 feet of Bethlehem 1⅞-inch wire rope having a hemp center. The speed of the hoists is regulated independently of their loads, and the torque is automatically limited by means of Westinghouse Rototrols. This device consists of two small direct-current generators that replace most of the switches, relays, and resistors conventionally used for the purpose. The man hoist operates at a maximum speed of 800 feet per minute when carrying persons and 1200 feet when carrying materials only. The ore skips travel at a maximum speed of 1800 feet per minute. Adjacent to the hoist house is the compressor house in which are three new Ingersoll-Rand Class PRK machines each of which has a piston displacement of 3864 cfm. and is driven by a Westinghouse 700-hp. synchronous motor. The air from each machine passes through a horizontal aftercooler to extract moisture, and the output of all three units is piped down the shaft through a 12-inch main.

An interesting feature of the shaft installation is a carrier-current signal system that makes it possible to transmit signals to and from the surface by the man-cage hoisting cable. This supplements the usual shaft signal wiring and has various advantages. Signals can be sent from within the cage, even when it is moving, and a signal previously given the hoist operator can be changed anywhere en route up or down the shaft. This saves time and promotes safety when repairs are being made in the shaft, for under the conventional system, signal stations are available only at the levels and orders must be shouted by the repair crew to a man at the nearest level and then relayed by him to the

NEW SURFACE PLANT

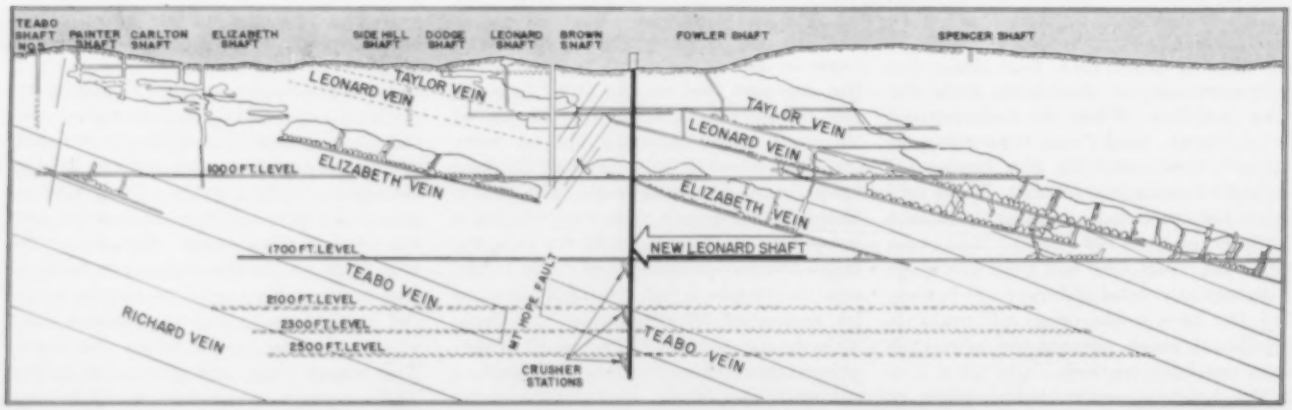
In the foreground are temporary structures used by the contractors.

surface. It is claimed that the system works equally well in wet or dry shafts, and there is no danger of signal wiring being severed or torn out by ore spilled during hoisting. This electronic cable-signaling system was developed by R. L. Rutherford of Superior, Ariz. It was first used in 1938 in deep shafts of the Magma Copper Company in Arizona and has since been adopted by several other large mines.

The Mount Hope property is believed to have been first worked in 1715, and it has been an intermittent producer ever since. Its total output is something more than four million long tons. The history of the mine was given in our March, 1941, issue. Since 1912, all production has been through the Brown Shaft—a 68° incline that extends 100 feet below the 1000-foot level. The ore bodies outcrop at the surface and are lath-like formations that have upward-disposed edges and that slope underground toward the northeast at an angle of 15° from the horizontal, with indications of steepening to around 19° with increasing depth. Their sides incline southeastward at an angle of 55° to 90° from the horizontal. There are several of these ore bodies, all parallel and disposed over an area 550 feet wide. Individual veins are from 6 to 40 feet wide, generally around 200 feet high, and of undetermined length, as no workings have penetrated deep enough to discover how far they go into the earth. In the zone penetrated by the Brown Shaft the ore bodies have been displaced 150 feet horizontally and 380 feet vertically by a fault plane that runs approximately at right angles to the vein system. This fault, called the Mount Hope Fault, divides the old workings into two sections, known as the north and south workings.

The property has been mined by running inclined drifts underneath the ore bodies from the 1000-foot level, those extending southward from the shaft bottom sloping upward and those extending northward being inclined downward. Stopes, generally about 210 feet long and with 30-foot pillars between them, are opened above the drifts to the full width of the vein and mined by the shrinkage system. As the ore is drilled and blasted off in successive overhead slabs, only enough is withdrawn after each shot through chutes installed below to afford the miners ample headroom for taking off another slice. This procedure is continued until the stope has reached the top of the ore body. The entire stope is then filled with broken ore that can be withdrawn as needed.

Most of the south workings have been depleted, because earlier operators followed the veins downward several hundred feet before the Brown Shaft was sunk. Consequently, the bulk of the production in recent years has been coming from the north workings, and the inclined drifts have been pushed continually deeper as they followed the dipping ore bodies. This has progressively lengthened the haul required to deliver the ore to the main 1000-foot haulage level, and thence to the shaft bottom for hoisting to the surface. The longest of the drifts, which is under the Taylor Vein, now extends for more than 4200 feet. Ore has had to be hoisted through it in two stages, then transferred to cars on the 1000-foot level, and again transferred into a skip at the shaft bottom. This multiple handling of ore and the progressively greater distance from the shaft at which the miners have

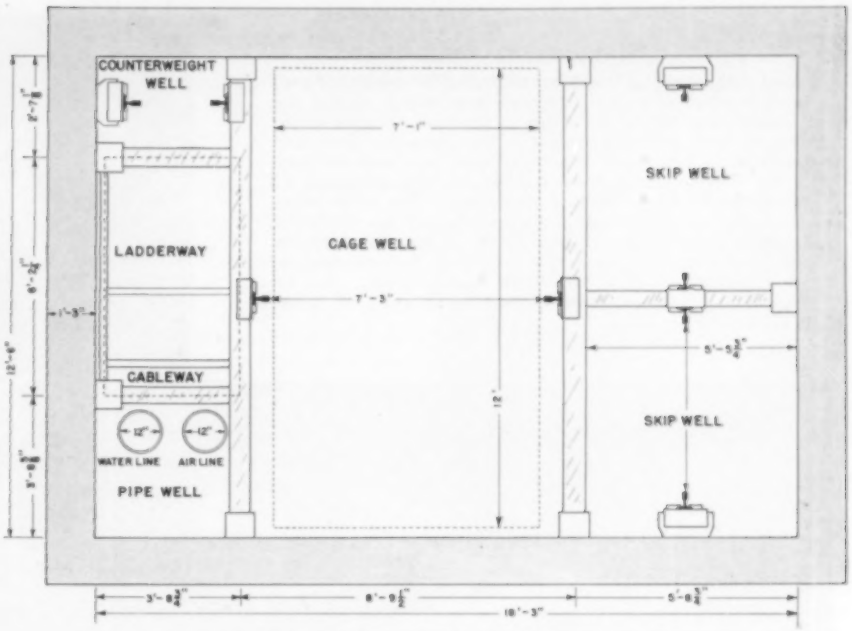


VERTICAL PROJECTION THROUGH ORE ZONE

This drawing shows disposition of the ore bodies and how their deeper sections will be reached through the New Leonard Shaft. Many older shafts are also shown, but production since 1922 has been through the Brown Shaft. The Mount Hope Fault, a shear zone up to 100 feet thick that has interrupted the continuity of the veins, is indicated near the center. The dotted horizontal lines show where three lower levels will be opened.

been working have inevitably added to production costs and prevented appreciably increasing the output. This was the situation in 1941 when the Government appealed for more ore to further the war effort. The only logical answer was a new development program such as is now being carried out.

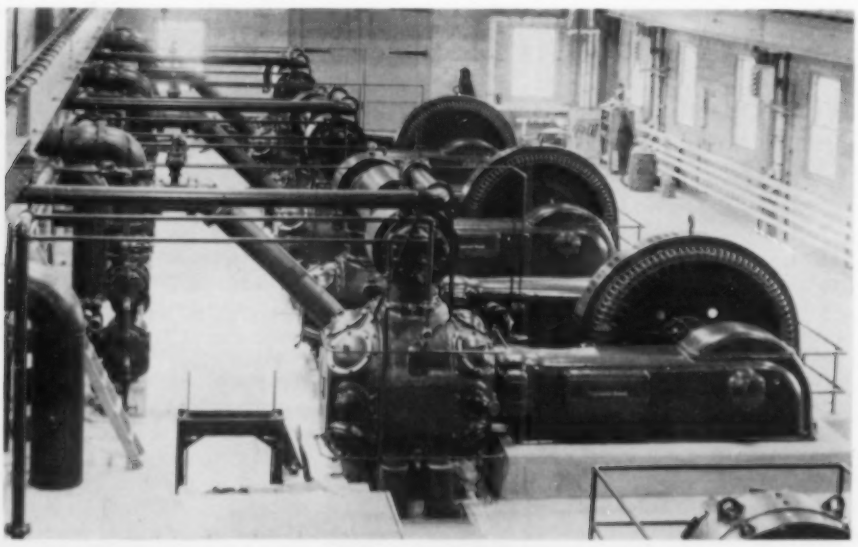
The new shaft, called the New Leonard, has been sunk vertically into the ground 1750 feet to the east of the Brown Shaft at the surface and 1450 feet on the 1000-foot level. The latter had already been driven far northward of the vertical extension of the new shaft before it was sunk and is, accordingly, available as a haulageway to it as well as to the Brown Shaft, which will be continued in operation for the time being. In addition, another level, at a depth of 1700 feet from the surface, was driven from the North Elizabeth incline northward to the lowest workings of the Taylor ore body and southward toward the new shaft while the latter was being put down. It was carried beyond the line of the new shaft and southward of the fault to tap the Teabo Vein which outcrops far south of the Brown Shaft and which, because of its dip, lies roughly 1000 feet below the bottom of the latter shaft.



CROSS SECTION OF SHAFT

Drawing shows dimensions and uses of the six compartments. The shaded border indicates the concrete lining.

As the existing facilities for treating the ore were inadequate for handling the increased production from the new shaft, it was necessary to include new milling plants in the scheme. This was desirable for another reason—because progress in the practice of concentrating magnetite ore had been so great since the older plants were built as to render them comparatively inefficient. The lump-ore mill at the Brown Shaft was the first of its kind. Prior to its construction in 1937 all magnetite ore was crushed, concentrated by the magnetic process, and the concentrate was sometimes sintered to give it the body and physical strength required of material charged into blast furnaces. By utilizing a system of passing a conveyor belt over magnetic pulleys, the Mount Hope management was able to offer steel mills magnetite lump ore (pieces $\frac{5}{8}$ inch and larger) for their open-hearth furnaces. The magnetic equipment was supplemented by a picking belt where trained workers further segregated ore and waste rock. This was required because lumps with ore only partly exposed might ride over the magnetic pulleys with the rock side up and consequently be attracted. By means of these facilities the mine was able to produce around 67½ percent of its shipping product in lump form averaging 62 percent in iron content. The fine ore was crushed and concentrated into a product averaging approximately 66 percent iron. In a typical year, 69 percent of the crude ore hoisted was marketed and 31 percent went to the dump as waste.



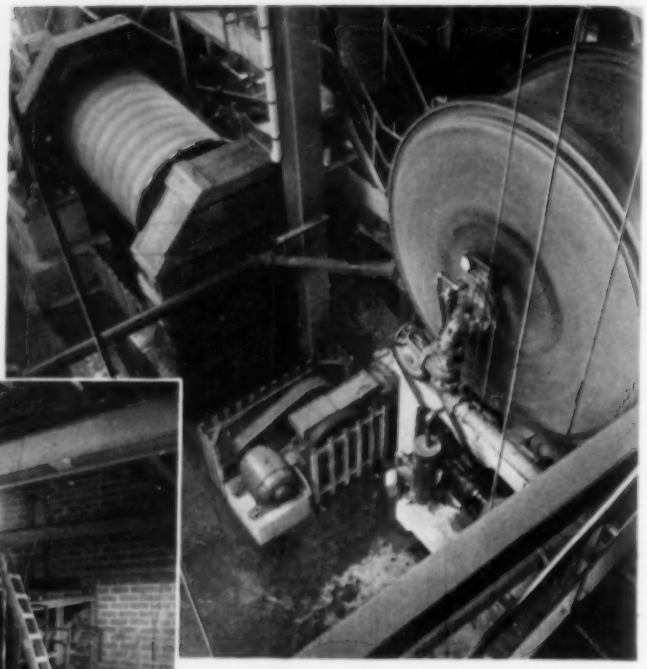
MINE COMPRESSOR PLANT

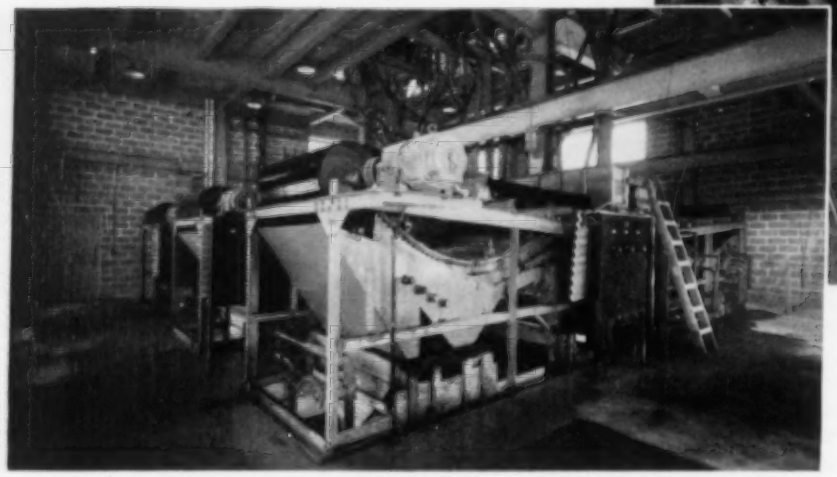
These three synchronous-motor-driven machines supply compressed air for operating rock drills, hoists, loading-pocket gates, etc., in the mine. They have a combined piston displacement of 11,592 cfm. The air delivered by them passes through the aftercoolers shown along the left wall and thence to receivers outside the building. A 12-inch main extends from the receivers down the shaft, and branch distribution lines on the different levels serve the various working places.

By contrast, the new facilities are expected to turn out up to 75 percent of the shipping product in the form of lump ore and to yield as high a grade of both lump and concentrate as any magnetite mine in the country, with a general ratio of concentration of 1.5 to 1. Using the old lump-ore mill and the new fine-ore mill, there was treated last year a total of 242,000 tons of material, consisting of 195,000 tons of crude ore and of 47,000 tons of so-called middlings from the old lump-ore plant that had been stockpiled during the latter half of 1943 after the fire in the old dry-concentrate mill. Because of the inclusion of these middlings, and the further fact that the crude ore was considerably diluted with rock as a result of the large amount of development work done in the mine, the total material treated last year had an average iron content of only 37.4 percent, as com-

CONCENTRATE MILL

Being magnetic, the ore is concentrated by passing it over electromagnetic drums and machines which attract the magnetite and allow the waste to pass on. Pieces larger than ⅝ inch are segregated in the lump-ore plant and marketed as lump ore. The remaining fine material goes to the 7-story concentrate mill where approximately 93 percent of its ore content is recovered. The view below shows a group of Davenport magnetic machines where the finished concentrates are produced. In the other picture, right, is a rotary vacuum filter in which the concentrates are dewatered before shipment; bottom-center, the Ingersoll-Rand vacuum pump that serves it; and, left, a rod mill used for grinding.





pared with a normal average of 46-48 percent. Despite these unfavorable factors 131,300 tons of ore was recovered, amounting to 54.3 percent of the quantity processed. Of this ore 61,325 tons, or 46.7 percent, was in the form of concentrates and 70,000 tons, or 53.3 percent, in lumps. The concentrates averaged 65.79 percent iron, in the dry state, and the lump ore averaged 61.40 percent iron. The new fine mill recovered 93.9 percent of the theoretical iron content of its input, and the tails had an average iron content of 4.55 percent iron, in the dry state.

Under the new operating set-up, crude ore is crushed to a maximum size of 6 inches in underground jaw-type crusher stations, loaded from pockets into skips, and hoisted and dumped into a crude-ore storage bin adjacent to the base of the headframe and having a capacity of 1600 tons. From this bin the ore is conveyed by belt to the top floor of the 7-story lump-ore plant from which it passes successively downward. It is first screened to produce two sizes: one under ⅝-inch mesh, which is conveyed directly to the fine mill for processing, and the other ⅝ inch to 6 inches, which undergoes treatment in the lump-ore plant. The larger material first goes over two magnetic pulleys arranged in series. There are two of these installations, and the flow is changed from one to the other every eight hours as the magnets become heated and lose some of their effectiveness. The magnets attract and segregate not only pieces that are rich in ore but also those that are largely rock with some areas of exposed ore. Further separation is therefore desirable to obtain lump ore high in iron content. To effect it, the material is passed from the magnets to a double-deck screen that produces three sizes: 6-2½ inches, 2½-1½ inches, and 1½ inches to ⅝ inch.

The largest size, 6-2½ inches, is fed to a picking belt that has stations for fourteen workers. As the material travels along, they allow the high-grade ore to remain on the belt, which conveys it to storage bins or railroad cars. They pick off rock that is essentially devoid of ore and place it on a belt leading to a waste-rock pile. An intermediate product, middlings, goes by way of another belt to a 2-inch jaw crusher and thence over a magnetic pulley. That portion of it which contains enough ore to be attracted by the magnets is carried back to the head of the circuit for reprocessing, while that rejected by the magnets passes to a cone crusher which reduces it to ¼-inch size before it joins the other material going to the fine mill. The 2½ to 1½-inch material is fed over a magnetic-drum separator that produces lump ore, rock, and half-and-half. The 1½ to ⅝-inch material undergoes similar treatment in another magnetic drum of different current intensity. In both cases, the half-and-half is crushed to ¼-inch size and goes to the fine mill.

All the material under ⅝ inch that is separated out in the lump-ore plant is conveyed to the top floor of the 7-story fine mill. This is a wet-process plant, which is somewhat more efficient than the dry process formerly used but is mainly more desirable from the health standpoint because it produces no dust. During its progress through the mill the material is carried by water. The incoming ore is distributed by an overhead regulating feeder to two vibrating 8-mesh screens. Material that is too large to pass through the screen is fed to a rod mill on the first floor to be ground and is then pumped back to the screen. From the screen it goes to magnetic machines, known as roughers, which produce a rough concentrate and tailings. The rough concentrate passes to a series of vibrating screens that separate it into four sizes. These are further treated in six magnetic finishing separators that were designed by Harry Davenport, now superintendent of the Mount Hope property and formerly in charge of the old dry mill. Four of these machines handle the two intermediate sizes, which are the greatest in quantity, while one suffices for each of the two other sizes.

The products in all cases are concentrates and tailings. The latter, as well as the tailings from the rougher separators used to effect the first concentration, go through a special rougher separator that is known as a policeman. It yields tailings and middlings, which latter pass to a rod mill for grinding and then back over one of the finishing separators. Tailings are dewatered by a drag rake and then conveyed to a dump. Concentrates are dewatered in a rotary vacuum-type filter and transferred to a

storage bin, or directly to railroad cars. Both travel on separate belts housed in the same enclosed bridge, which contains steam pipes to prevent the materials from freezing during cold weather.

The fine-ore mill uses a great amount of water, and a supply is also needed for the miners' change house and other purposes. To furnish it, a reservoir was created by erecting a low earth dam at the end of a peat bog south and east of the new surface plant. It receives the runoff from 1250 acres of higher land surrounding it and also the water pumped from the mine. Although the reservoir has a surface area of 216 acres exposed to the evaporative rays of the sun, the water level was not perceptibly lowered during the unusually hot and dry summer of 1944. From a pump house containing two 1500-gpm. and one 3000-gpm. pumps, reservoir water is elevated to a water tank that rises 138 feet above the ground surface. The plant supply is obtained from the tank by gravity flow. After water has been used in the fine-ore mill, it is run into the reservoir at a location where it will not soon be withdrawn. This permits the solids carried to settle out and provides the pumps with clear water at all times.

The new shaft is one of the largest and deepest ever put down in the eastern part of the country. Including a 39½-foot sump, it is 2674 feet deep. It measures 12 feet 6 inches by 18 feet 3 inches inside its concrete lining, which has an average thickness of 15 inches and a minimum of 8 inches. The shaft was sunk under contract by the Underpinning & Foundation Company, New York. The cage, skips, landing chairs, and ore-pocket steelwork were made by the Union Iron Works, Elizabeth, N. J. Excavating and concreting were done concurrently, that phase of the work having been started on November 7, 1941, and completed on March 3, 1944. The setting of steel and installation of cages, skips, pipes, cables, etc., consumed an additional eleven months, and the finished shaft, ready for operation, was turned over to the mining company on February 1, 1945. In addition to constructing the shaft proper, the contractor cut stations at five levels and at four of them built skip-loading pockets, each 28 feet high, 18 feet 3 inches wide, and 23 feet deep. The operations involved the excavating and removal of approximately 27,000 cubic yards of rock, measured in the solid, and the placing of some 8000 cubic yards of concrete in forms.

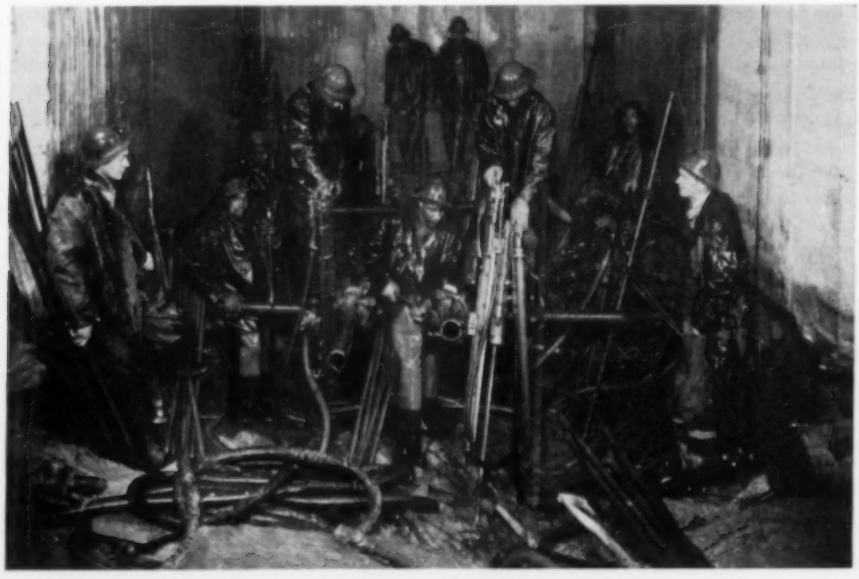
As the prevailing gneiss country rock reaches the surface at the site selected, the work required drilling and blasting from the outset. A temporary steel headframe 65 feet high was put up to get operations underway, and the permanent 148-foot steel headframe now serving the mine was erected while sinking was in progress. As soon as the latter was completed, it was utilized by the contractor. It is equipped with sheave wheels 12 feet in diameter and 120 feet above the ground surface. A Lidgerwood electric hoist, driven by a 600-hp. motor and wound with 1¼-inch nonspinning wire rope, was used for the sinking operations. This unit, which had previously seen service on one of the shaft-sinking jobs of the Delaware Aqueduct of the New York City water-supply system, was equipped with brakes operated by compressed air. The air was ordinarily obtained from the contractor's distribution lines, but a small Ingersoll-Rand air-cooled compressor was set up in the hoist house for emergency service. A smaller air hoist was employed in erecting the permanent headframe and thereafter served as a standby, pinchhitting on three occasions for the main hoist when it became incapacitated because of power failure. Round buckets of 1¼-cubic-yard capacity were used during the early stage of the work for handling men, muck, and materials and were later replaced with similar ones of 2-cubic-yard capacity. Guides were run down the shaft for 1650 feet, below which point the bucket swung free.

SHAFT SINKER

Luther Curtis, superintendent for the Underpinning & Foundation Company during the sinking of the new 2674-foot shaft.

Drilling was done with both Jackhamers and drifters. Because they can be moved about more readily and require no time for setting up, Jackhamers were utilized wherever relatively soft ground was encountered and drifters in harder ground. Two veins of ore were passed through, one being entered at a depth of 1500 feet below the surface and the other at about 2160 feet. Approximately half of the work was done by Jackhamers and half by drifters. All drills were of Ingersoll-Rand make, there being fourteen wet-type S-68 Jackhamers and six DA-35 drifters on the job. When drilling with Jackhamers, eight machines were ordinarily used. When drifters were employed, four were in service, being mounted two each on two bars set up across the shorter dimension of the shaft. Compressed air was delivered to manifolds, from which there were hose take-offs to the individual drills. In each of the latter was interposed an air-line oiler to insure adequate lubrication at all times.

A drill round consisted of from 52 to 56 holes averaging from 8 to 10 feet



DRILLING IN THE NEW LEONARD SHAFT

This picture was taken when the shaft was nearing the bottom. Four DA-35 drifters are mounted two each on cross bars spanning the narrower dimension of the opening. These machines were used in the harder rock sections, but approximately one-half of the drilling was done with hand-held Jackhamers. Note the concrete lining which has been extended almost down to the drilling floor.

deep. A V-cut was made extending across the midsection between the sides of the opening. These holes were shot first, and those at either side of them were then fired progressively so as to break to this continually widening cut. The center section was always shot and mucked a foot or two lower than the rest of the bottom. This provided a sump to which all water drained and kept the remaining areas dry.

Hollow, round 1⅛-inch Jackrods and 4-point Jackbits were used with the Jackhamers. Starters had a maximum diameter of 2¼ inches, and a reduction of ⅛ inch in gauge was made with each succeeding bit change. A total of 34,000 bits was employed in sinking the shaft. Hollow, round 1¼-inch conventional sharpener steel was utilized with the drifter drills, holes being started with bits of 2⅜-inch gauge. The time required to drill a round varied from 4 to 8 or 9 hours, depending upon the hardness of the rock. As each hole was completed, it was blown out with compressed air and stopped with a wooden plug to mark its location and to keep out dirt.

Holes were loaded with 40 percent Atlas gelatine dynamite, the average consumption ranging from 350 to 400 pounds per round. Primers were made up at the shaft bottom, electric blasting caps up to eight delays being used. Shooting was done from the surface or from shaft stations after all drilling equipment and men had been hoisted. The average advance in depth per round was approximately 6 feet. Mucking was done by hand shoveling. The time required to clean up a round was about twelve hours in the beginning. This gradually rose to 14-16 hours as depth increased and more time was consumed in hoisting and lowering the bucket. The maximum rope speed of the hoist was 750 feet per minute. The average time for a cycle of drilling and mucking was 22-23 hours.

SHAFT-SINKING EQUIPMENT

A view in the contractor's blacksmith shop where drill steel was reconditioned. It shows a bit being forged on a piece of 1¼-inch steel in a No. 50 sharpener.

The maximum flow of water into the shaft was around 50 gpm. During the first 1000 feet of sinking this was pumped to the surface by Ingersoll-Rand Motorgumps, additional units being set up with depth until three were being used in series. During the remainder of the work the water was pumped to the 1000-foot level of the mine and raised from there to the surface by the mine pumps. Ingersoll-Rand NT-4 pumps served during this latter period. One unit handled the water down to the 1700-foot level. It was then stationed there and a second unit installed in the shaft as a booster to that point. The second pump was stationed at the 2500-foot level when the shaft reached that depth. Two air-operated sump pumps were used at the bottom for pumping casual water into the hoisting bucket during mucking.

Concreting of the first 1000 feet of the shaft was ordinarily done once a week, and frequently twice weekly thereafter if "popping rock" was encountered, the aim being to keep the unlined section down to a safe distance for scaling the sides above the bottom. Six-foot steel forms were employed, and it was necessary to lower these from the surface each time they were set up and to hoist them out of the shaft after the concreting cycle had been completed. Concrete was hauled to the shaft head in transit-mix trucks from Kenvil, N. J., a distance of 8 miles, and was delivered directly into the shaft bucket. As depth increased, the time required to transport both forms and concrete in the shaft became progressively greater, and the work was slowed up proportionately. Normally, five rounds, equivalent to around 30 feet, were excavated and concreted weekly, and the best performance registered was 46 feet in one week.

Every 96 feet vertically, a bearer set of steel was anchored in the concrete, and these sets form part of the ordinary steelwork subsequently placed throughout the shaft to subdivide it into compartments. A 4-inch air line and a 2-inch water line to supply the drills, a 6-inch water discharge line, and two 8-inch ventilating ducts were all embedded in the concrete. Ventilating air was supplied from the surface until the 1000-foot level was passed, after that the blower was moved to that level. Air was normally blown down the shaft, but after each blast it was exhausted for fifteen minutes to remove smoke and powder fumes.

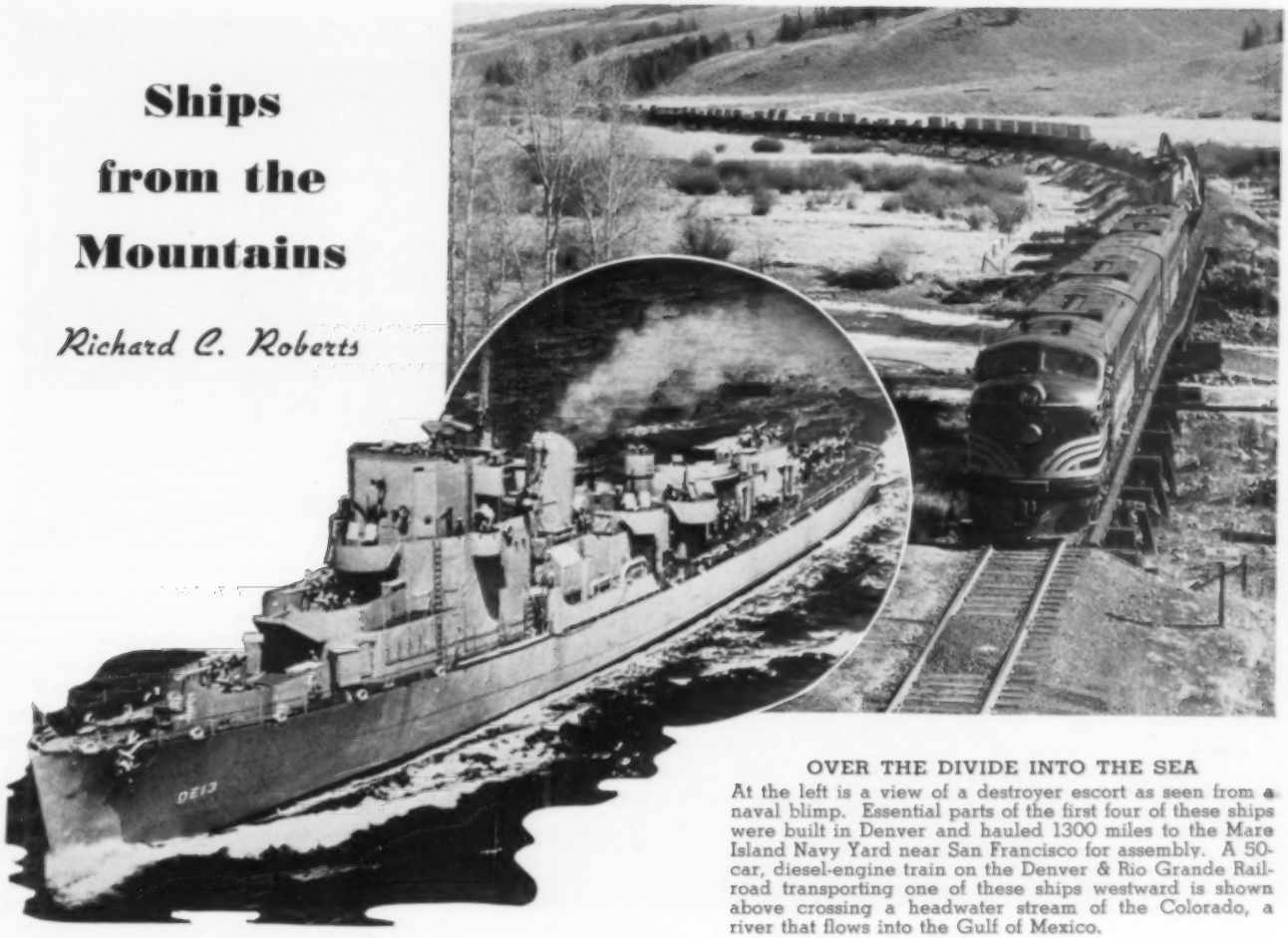
Compressed air for the shaft-excavation work was furnished by an Ingersoll-Rand 14-inch-stroke Class PRE-2 machine driven by a 200-hp. Westinghouse synchronous motor. During the summer of 1943, a bolt of lightning burned out the motor, and three I-R portable compressors were brought in to provide temporary service. They remained as standby units. The contractor maintained a blacksmith shop with complete Ingersoll-Rand equipment for reconditioning drill steel. Jackbits were resharpened by a J2 and a J3 grinder, and both shanks and threads were swaged on the Jackrods in a No. 50 sharpener. The same unit served for all reconditioning operations on the solid forged steel used by the drifter drills, and there were two 27F oil furnaces for heating the steel. All the steel and bits required for a round were sent down the shaft at one time. Jackbits were delivered in boxes having compartments for the different sizes. Used bits were placed in another box on the shaft bottom to be brought to the surface for resharpening.

The steelwork that divides the shaft into compartments consists of horizontal sets of 12- and 8-inch H-beams hung on 6-foot centers and interconnected by the steel guides. It was made up by the American Bridge Company and totaled approximately 1000 tons in weight. Installation was started at the shaft bottom and carried progressively upward. To facilitate this, the bucket that had been suspended from the hoist cable during the excavating operations was replaced with a platform that could be extended at the sides to give the workmen access to all parts of the shaft cross section. All seat angles, brackets, and guide supports were secured to the concrete lining with 1-inch bolts, 6 inches long, that were screwed into Star double-expansion shields of rustproofed malleable iron. Each shield necessitated the drilling of a hole 1¾ inches in diameter and 6 inches deep, there being an average of 40 of them for each set, or more than 17-000 in the shaft. They were put in with the S-68 Jackhamers that had previously been used in excavating. Drilling was done with Jackbits, the number required for the purpose being 3000.

Approximately 450 men will be needed to operate the mine at its new capacity; but, in view of the manpower shortage, it is difficult to forecast how soon a full working force can be obtained. The present payroll of around 150 will be increased as rapidly as more employees become available. Meanwhile, the kind of ore produced at Mount Hope is in demand, and existing agreements assure a market for virtually the entire capacity output for five years ahead.

Ships from the Mountains

Richard C. Roberts



OVER THE DIVIDE INTO THE SEA

At the left is a view of a destroyer escort as seen from a naval blimp. Essential parts of the first four of these ships were built in Denver and hauled 1300 miles to the Mare Island Navy Yard near San Francisco for assembly. A 50-car, diesel-engine train on the Denver & Rio Grande Railroad transporting one of these ships westward is shown above crossing a headwater stream of the Colorado, a river that flows into the Gulf of Mexico.

FROM a shipyard located a mile above sea level and half a continent from the nearest coast line have come vessels that are plaguing German U-Boats and that are slamming shells at Japanese island fortifications. Destroyer escorts, tank landing craft, and work-horse floating piers—all have been built in this amazing inland yard. No champagne bottles were smashed across the bows of these ships when they were "launched," and they didn't slip down smooth ways into a bay. Instead, they were loaded onto long trains of flat cars—50 cars to a vessel—and made their way across the Rocky Mountains to the Pacific Coast.

The story of this remarkable shipyard in Denver, Colo., is a perfect example of American production ingenuity and a striking illustration of how large and small industries have worked together in order to give the United States the most powerful navy in her history. One of the leaders among the firms coöperating in the shipbuilding project was the Thompson Pipe & Steel Company of Denver. This concern, which helped to solve one of the construction problems of the Navy, had its beginning in 1878 when a totally different kind of problem confronted it. At that time the West was growing rapidly, and industry was pushing deep into the mountains.

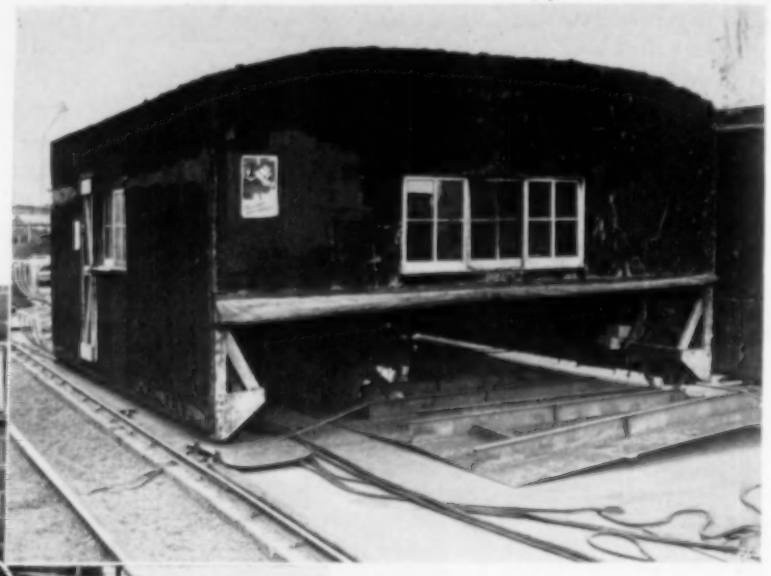
The transportation of heavy supplies through the rugged country for various building operations was a job that was baffling construction engineers, miners, and ranchers. Since most of the work involved the use of large pipe, that material had to be brought into the mountains from the East. Sometimes it could be shipped in over a tortuous narrow-gauge railway; but more often it had to be packed in by wagon train or mule back. One of Colorado's early manufacturers, John Young, foresaw the need of light, thin-walled pipe in the West and built a plant in Denver to supply it.

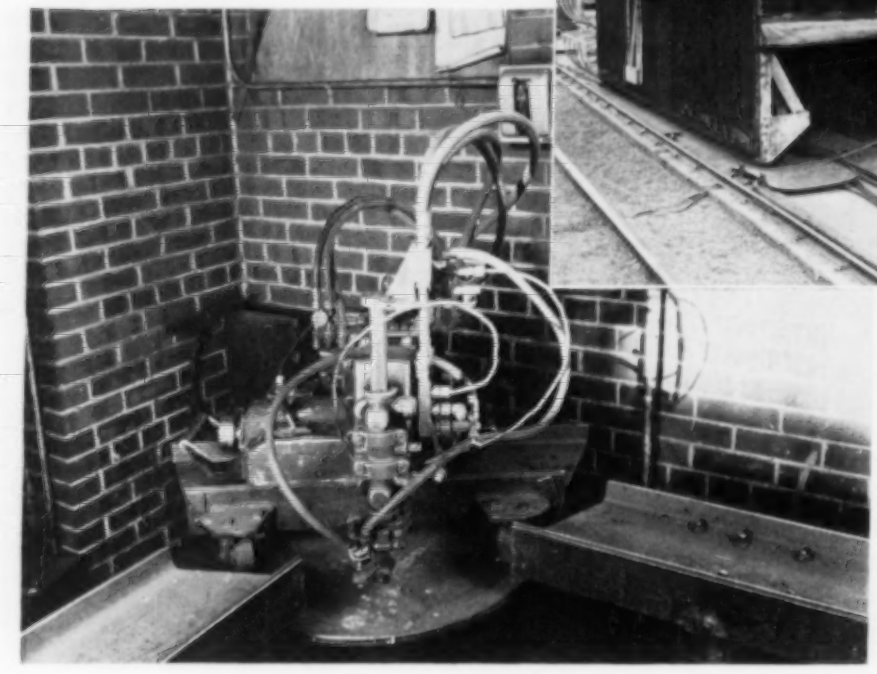
In the early 1890's, William A. Weigele began business and bought Young's interest in the firm. Weigele continued to make pipe for mining, power development, and irrigation until 1921, when failing health caused him to sell his interest to the Thompson Manufacturing Company. Four years ago the latter organization changed its name to its present one of Thompson Pipe & Steel Company in order better to describe its products. As it grew in size, the concern expanded its line to include pipe, smokestacks, corrugated-metal highway culverts, tanks, well casings, and general plate fabrication. During the present war, in addition to its work for the Navy, the company has continued to supply enough of its peacetime products to meet the needs of municipal water systems and other essential public services.

The construction and engineering facilities of Thompson Pipe & Steel were enlisted early in America's defense program when the company built the twin penstocks for the Green Mountain Project near Kremmling, Colo. This hydroelectric development is part of the giant Colorado-Big Thompson Diversion Project, which includes the Alva B. Adams Tunnel beneath the Continental Divide, and was rushed to completion to provide additional power for the Rocky Mountain Arsenal situated near Denver. The penstocks of the Green Mountain power plant have a diameter of 8.5 feet and a plate thickness ranging from ¾ inch to 1¾ inches. An unusual feature of their construction was the thorough X-ray examination of every welded joint. This inspection required the use of more than $10,000 worth of X-ray film. Today the industrial X-ray equipment at Thompson Pipe & Steel is being utilized by Colorado munitions makers in research and development work.

AIDS TO WORKMEN

Mobile shelter houses (right) enabled outdoor work to be carried on throughout the winter and did not interfere with the free movement of the overhead crane in the yard. Another time saver was the turntable shown below. It permitted the cutting-machine operator to run his torch down one rail, to turn it, and then to make another cut at right angles to the first one.





In the beginning of 1941, G. H. Garrett, vice-president and general manager of the company, began looking around for war products which the plant was equipped to manufacture. Navy officials in Washington suggested that he consult with Capt. (now Rear Admiral) Frederick G. Crisp, commandant of the Mare Island Navy Yard in California. Long before the war broke out in the Pacific, Mare Island officials had been anxious to obtain the services of the inland steel fabricators and sent officers to Denver, among other places, to check the production facilities there. As a result of this investigation the Navy Yard set up a coördination office in that city under the supervision of Earl Tobin. This organization began the monumental task of training Colorado workers, most of whom had never seen a sea-going vessel, in ship terminology and fabrication methods. A school was established and classes were held twice each week.

Final negotiations in connection with the first naval contract were completed in December, 1941, and preparations for the job had been so thorough that actual construction was started in February, 1942. Nine Denver firms, all prime contractors, participated in the original work, each company making whatever parts its plant equipment would permit. The project became known as the "Denver-Mare Island Plan," and was successful from its inception. The initial contract called for the building of 39 destroyer escorts and was based on an estimated cost of $3,000,000 per boat. As production progressed, this estimate was revised again and again, until the Denver shipyards had cut the cost to $1,000,000.

Materials for the first vessels were the chief problem, and had to be purchased here and there, wherever some could be found. All of it was shipped to the Weicker Transfer & Storage Company, which pickled and painted it and then distributed it among the contractors. The same concern also transported the finished parts to a central shipping point, where they were loaded on Denver & Rio Grande Western Railroad trains for the long haul to the Mare Island Navy Yard, where they were assembled.

When the material was delivered to Thompson Pipe & Steel, wooden templets or patterns were used in scribing and center-punching the steel plates, and all fabrication directions were painted on them. Power-driven Oxweld CM21 torches then cut the plates to their required shapes, and a similar unit beveled the edges preparatory to welding. As the latter work was first done, it was necessary to move each heavy plate after one edge had been finished and before the next one could be beveled. H. Jackson, plant superintendent, solved this problem neatly with an ingenious turntable for the cutting torch. The set-up was arranged in one corner of the fabrication floor, and two rails were placed at right angles, one running along each wall. The turntable was mounted at the intersection of the rails so that the power-driven machine could be run over one rail onto the turntable and rotated until it was in alignment with the other track, along which the second cut could be made. This device speeded up beveling enormously, for it enabled the cutting-torch operator to prepare two plate edges with virtually one set-up.

Since newly trained men had to be employed for a large share of the work, Unionmelt automatic welding machines were used wherever feasible. As a further aid to the "green" welders, fixtures were designed to hold hand-welded parts so that most of the work could be done in the easiest way—with the flame directed downward. Huge trunnions were constructed to carry the fixtures in order that large assemblies could be rotated and thus placed in the most convenient position for welding. Model 3F Ingersoll-Rand air-driven grinders were employed throughout the shop for smoothing welds and for general grinding. It is reported that the adoption of these tools reduced the cost of grinding wheels from 22 to 2 cents per wheel per hour.

Wherever American workers have attacked the war-production problem they have contrived countless homemade "gadgets" to speed operations, and the men at Thompson Pipe & Steel have been no exception. A welder found that an old phonograph motor and turntable would serve him to advantage by revolving a small part at just the right speed for his work. When a vacuum flux reclaimer on a welding machine failed to function properly, shopmen located a

central vacuum-cleaning unit that had been discarded by a Denver hotel. After it was put in shape it did a better job than the equipment it replaced.

Much of the work of shipbuilding has to be done in the open where the men are exposed to the weather. But at the Thompson yards, those busy on deckhouses were protected on wintry days by composition-board shelter houses that were large enough to cover those superstructures. The shelters were mounted on wheels, and when an overhead crane had swung an assembly into place, a house was rolled over it, the men being hard at work the while. As soon as operations on one assembly had been completed, the shelter could be shuttled over a new one. This arrangement gave the overhead crane free movement in the yard and provided cover for welders as soon as their work was set up for them. In connection with the crane, it is worth mentioning that it was necessary to provide a new one when building operations on the destroyer escorts were begun. However, it was impossible to find one at the time, so Thompson men constructed a crane with materials that were available.

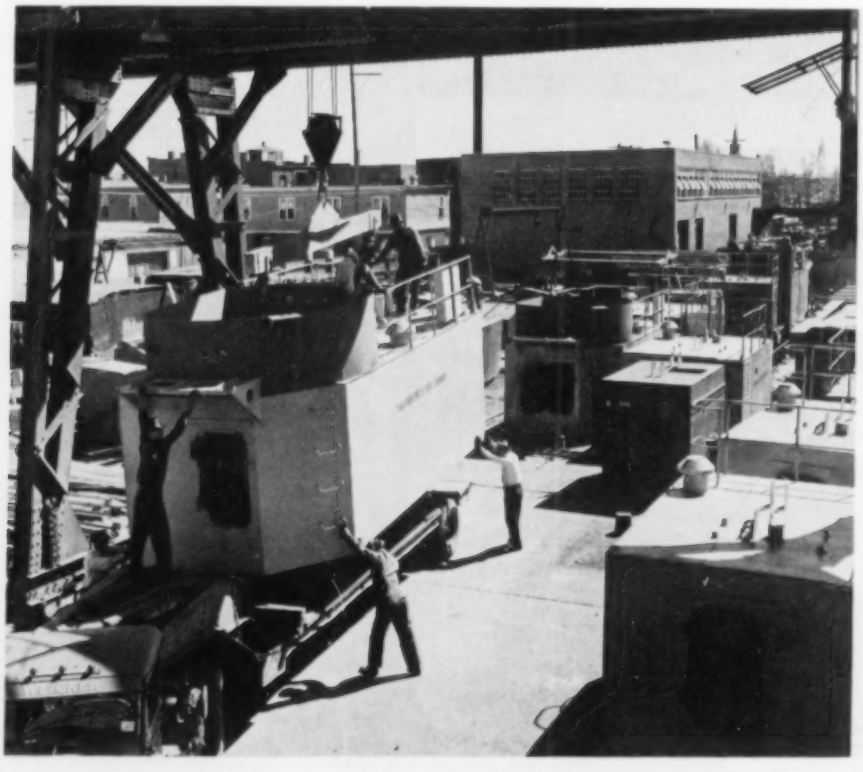
To meet the Navy's ever-increasing production schedules, the company realized that the yard had to be enlarged. The logical direction for expansion was to the east, but on that side the plant bordered Thirty-first Street. This difficulty was overcome when the city officials of Denver consented to close off the thoroughfare where it adjoined the property, thus permitting it to be extended across the street and the opposite city block.

But even this doubling of the shop and plant facilities was not enough to meet production schedules, so the company leased the idle works of the Consolidated Cut Stone & Granite Company in the autumn of 1942. Although located on the opposite side of the city from the main Thompson plant, equipment was moved and operations started within a week from the time the lease was signed. The Consolidated establishment was small and was used only as an auxiliary during peak production periods on the Navy contract. At such times, employment was increased 400 percent, as against 350 percent when shipbuilding was proceeding normally. The entire program of expansion was financed by the Thompson firm without government assistance, and gives the company greatly increased facilities for the manufacture of its regular products.

When the destroyer-escort contract was completed, the yard began the construction of floating-pier barges for the Army Transportation Corps. These are the big 50x150-foot vessels that serve as lighters in transferring cargoes from ship to shore in the case of small landing operations and that are fastened end to end to form floating piers for large-scale military landings. So connected, trucks can be driven over them directly to freighters for unloading. On this job Thompson was the prime contractor, but sublet some of the work to other companies in Denver and Pueblo, Colo., and Omaha, Neb. Deckhouses, hull sections, and smaller parts for LCT6 (landing craft) made up the next Navy contract for Thompson. The LCT6, which disgorges its cargo of tanks on enemy beaches, is one of America's outstanding contributions to amphibious warfare.

PNEUMATIC TOOLS HELPED

A workman using a Model 3F grinder to smooth a weld on a ship plate. Electric-driven tools were first employed; but after one of these air-driven grinders was tried out, the Thompson shop standardized on that type.



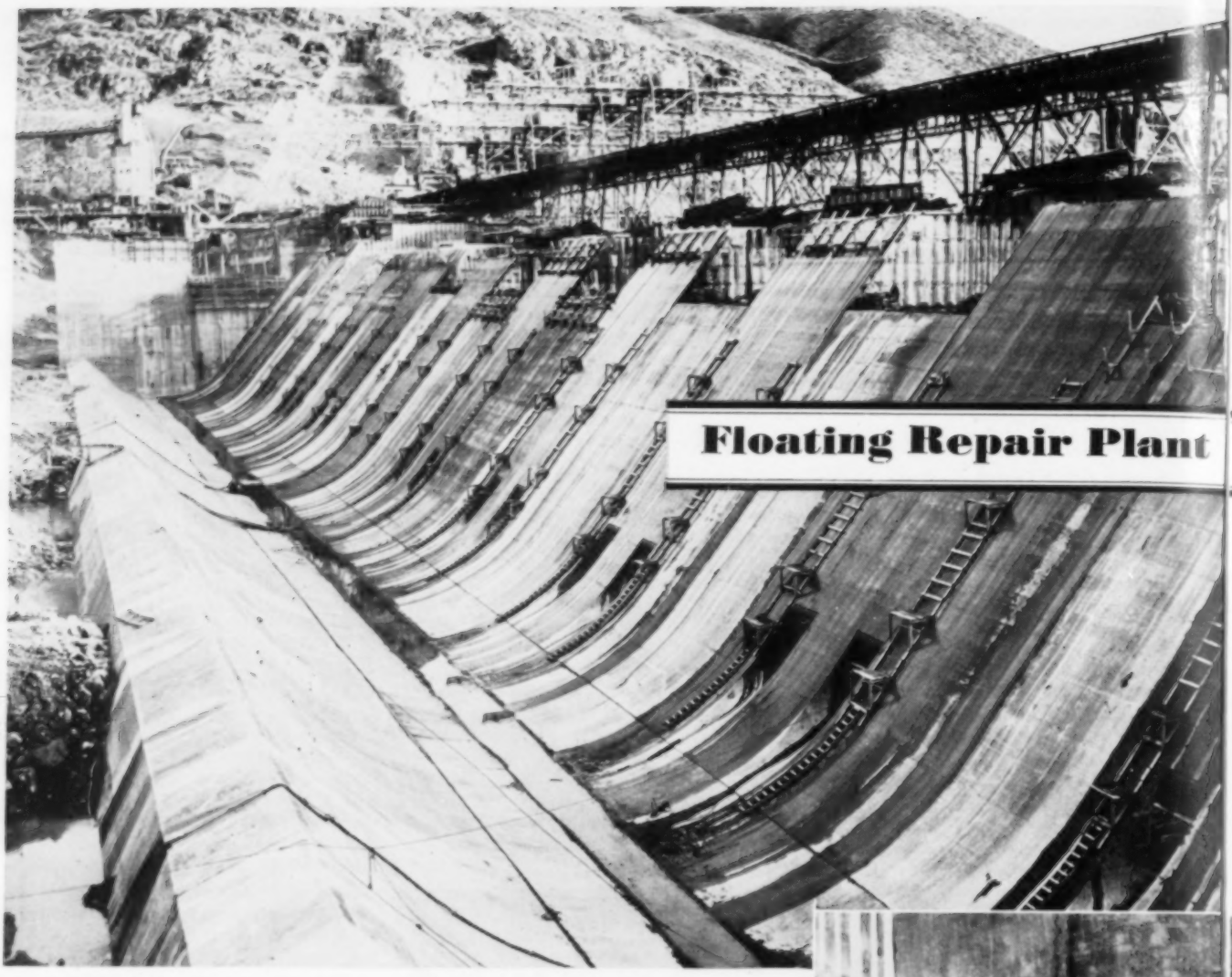
A LAUNCHING IN DENVER

An overhead crane lowering a deckhouse on a trailer truck. All parts were hauled to a central point for loading on freight cars.

The company also was assigned the responsibility of preparing an instruction book to be used in assembling the 50x150-foot barges at staging points. After engineers had completed the manual, one of the lighters was put together in Denver to check the accuracy of the instructions. Of the scores of boats constructed under the entire Denver-Mare Island Plan this was the only vessel to be entirely assembled in land-locked Colorado.

The officers who directed Thompson Pipe & Steel Company during the shipbuilding program were: J. L. Brown, president; G. H. Garrett, vice-president and general manager; N. J. Thompson, secretary; S. M. Davidson, chief engineer; and H. Jackson, plant superintendent. Other Denver companies which coöperated in carrying out the plan were: Ajax Iron Works Company, Hardesty Division of Armco Drainage & Metal Products, Inc., Denver Steel & Iron Works Company, Eaton Metal Products Company, Midwest Steel & Iron Works Company, Silver Engineering Works, Inc., and the Winter-Weiss Company.

Floating Repair Plant



GRAND COULEE DAM is the greatest concrete barrier so far built to block the normal flow of any river. But many of us are unaware of the tremendous potential force that is stored in the impounded water and that may be given full rein during flood periods when the water is released and goes racing down the high spillway of that structure. If not controlled, it may do an immense amount of damage to the dam itself. Some hint of this is given by what has already occurred in the stilling basin at the toe of the barrier. This basin is novel in form and was designed to rob the spillway discharge of its battering, wearing impulse.

The spillway of Grand Coulee Dam has an over-all length of 1650 feet between the flanking training walls that guide the overflow water in its swift course from the reservoir level to the surface of the tailrace at the downstream side of the structure. The lip of the spillway is equipped with eleven drum gates, and should all those gates be housed at a time of extraordinary flood stage to release the water stored in the reservoir, which extends upstream at flood level for more than 100 miles, it is estimated that as much as one million cubic feet of water per second would pass through the gateways and gain momentum during its descent of 280 feet into the tailwater.

To put it another way, the overflow along every foot of the spillway would be as much as 600 cubic feet a second, and Kenneth B. Keener, the U. S. Bureau of Reclamation designing engineer on dams, has said: The energy stored up in that falling water would reach the equivalent of 31,845,000 hp. The impact and the sweep of such a torrent would be capable of eroding the toughest rock; and if that action continued, or were not slowed up in some way, both the toe of the dam and the rocky bed of the river for some distance downstream would be worn away—and perhaps the toe might be dangerously undermined.

The men responsible for the design of Grand Coulee were alert to what was involved in rearing so high a structure to impound flood volumes of the Columbia

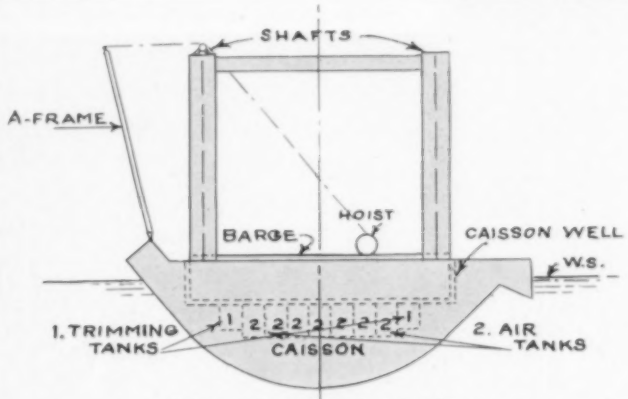
River. So they provided a massive curved barrier at the downstream toe of the spillway into which all water released over or through the latter could be robbed of much of its momentum and capacity to do harm to the dam or the river bed immediately below. The aim was to check the impetuous onrush momentarily by somersaulting the water back on itself before leaving it free to continue its course downstream. The bureau has embodied kindred but different structures for the same purpose in many of its other big dams; but in the case of Grand Coulee the stilling basin, for excellent engineering reasons, is a submerged bucket—really an immense gutter that has a depth of about 30 feet, a maximum top width of approximately 105 feet, and extends from training wall to training wall.

When the water strikes the basin it is shot upward and to a great extent backward on itself, the remainder at the same time falling over the downstream lip of the bucket and plunging downward and backward on itself. These two revolving motions dissipate a large part not only of the directive force but also of the momentum of the water and turn it loose as an eddying and relatively slower-moving body. The reversed currents in and close to the discharge lip of the basin still retain a great deal of energy. They are strong enough to pick up sand, gravel, and even boulders downstream of the toe of the dam and to sweep them upstream into the bucket. There the swirling waters convert the transferred materials into abrasives that have been responsible for widespread erosion and, in the case of the boulders, been capable of boring sizable potholes.

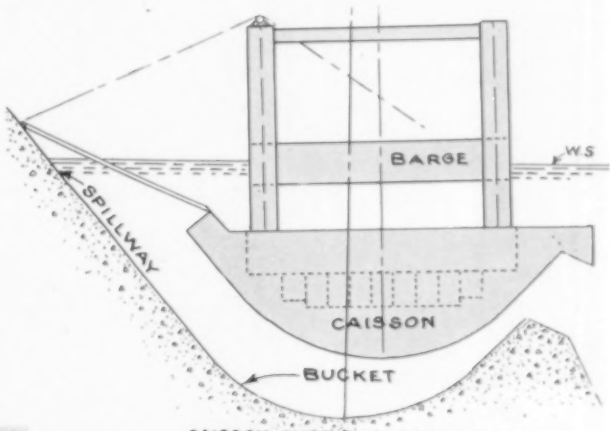
The nature and extent of the various erosive actions thus induced in the basin were first discovered during a subaqueous inspection made for that purpose in March of 1943 by divers. The surface concrete of the bucket was found to be worn away to depths ranging from 1 inch to as much as 18 inches, the affected areas being distributed throughout the whole length and width of the basin. It may occur to some of our

for Grand Coulee Dam

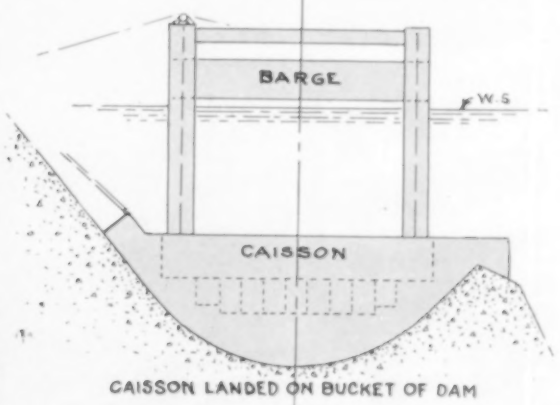
R. G. Skerrett



CAISSON IN FLOATING POSITION



CAISSON OVER BUCKET OF DAM



CAISSON LANDED ON BUCKET OF DAM

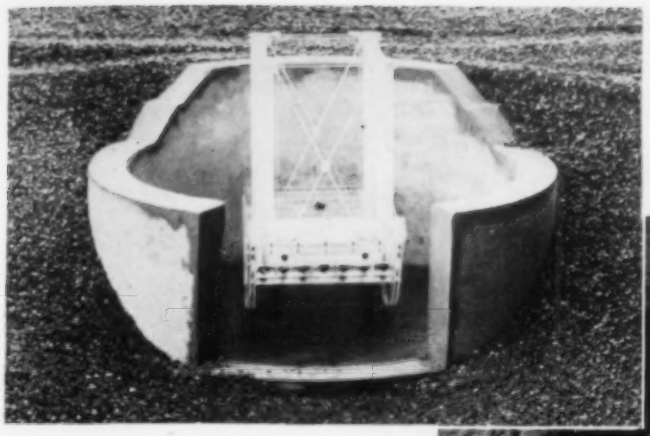
HOW FLOATING CAISSON WILL BE USED

At the top-left is a section of the bucket at the base of the spillway section of the dam, showing how it is shaped to somersault the falling water back on itself and thus partially arrest its force. A photograph of the model of the caisson and basin used by Bureau of Reclamation engineers in developing the new maintenance facilities is reproduced at the left. The cross-sectional drawings indicate how the caisson will be floated in the spillway bucket and sunk into place preparatory to dewatering it to give access to the concrete for repair work.

POURING CONCRETE FOR THE CAISSON DRY DOCK

readers to ask why this inspection was not made sooner and steps taken to deal with the situation?

The answer is that circumstances were not favorable earlier because the hydraulic conditions at the dam were continually changing while the structure was rising to its final height—to the stage where the spillway gates could be installed to raise the reservoir level an additional 28 feet. A period of about seven years has elapsed since Grand Coulee reached an elevation that permitted the basin to be permanently and completely flooded, and during the initial five years of this full service an estimated 346 million acre-feet of water poured down into that structure and delivered to it impacts of differing magnitude that caused diversified injuries. Also, despite the exercise of care during



DRY-DOCK MODEL AND EROSION AGENTS

At the left is a cutaway model of the dry dock with the caisson inside as it will be stored when not in service. Below are pictured pieces of structural steel and boulders of varying sizes that were removed from the bucket of the dam. They show evidence of having been tumbled around by the swirling waters and of having acted destructively on the concrete basin.

the construction period, it was not possible to prevent heavy materials from falling into the bucket, with the result that the forceful eddies at the toe of the dam caused some of those materials to become active damaging agencies.

The 1943 inspection was carried out by the divers at considerable risk and with much difficulty. Although the water was clear, and the workers could see for a distance of as much as 12 feet by daylight, it was very turbulent and there were swift currents within the basin, the low point of which lay at a depth of 68 feet below the minimum surface of the tailwater. The water had a temperature of 37°F. The divers operated from a small barge held in position by the boom of a larger barge that was controlled by maneuvering a number of mooring lines. The subaqueous work covered an interval of twenty days.

A second inspection was carried out in November and December of 1943, at which time the water was as much as 22° warmer than during the initial one, and the river flow was such as to make the task easier for all hands, especially the divers. All told, 83 dives were undertaken on seventeen days. The net result of the examination was gratifying because it revealed that the rate of erosion had dropped even though the expanse of the damaged areas had increased and that there was no evidence that the dam itself had been injured. At this writing, plans are being made for a third inspection. This prelude brings us to the means that the Bureau of Reclamation has long had under contemplation for periodic examination of the basin and for carrying out such repair work as may be necessary to maintain the bucket in a satisfactory condition.

The equipment is the outcome of model experiments made near Grand Coulee Dam on a scale that would give dependable results. The model is on a 1:60 ratio. The tests disclosed that a discharge down the spillway of 500,000 cubic feet a second in the case of the actual dam would attain a maximum velocity by the time it reached the tailwater of 133 feet per second, while the water leaving the basin at the downstream lip would have a velocity of only 55 feet a second—a reduction in speed of something more than 58 percent. This is striking evidence of the effectiveness of the bucket as a stilling basin. The model also was used to test a floating caisson built on a commensurate scale and designed to facilitate inspection and maintenance of the spillway bucket.

The full-size caisson is now under construction at Grand Coulee Dam in a circular basin that will serve as a dry dock for the caisson when not in active service. This dry dock is on the east bank of the Columbia River and a short distance below the dam. It has an internal diameter of about 160 feet and is equipped with a wide portal provided with a miter gate operated by oil-driven hydraulic pistons under a pressure of around 400 pounds per square inch. The body of the dock is of reinforced concrete and was sunk as an open caisson through gravel and sand to its required depth in bedrock.

The caisson is a mobile, rectangular structure that will be floated out of the dry dock and drawn to the desired position at the foot of the spillway by maneuvering cables leading from pullers or winches adjacent to the dock. Lateral control will be effected by lines leading from the caisson to five other winches—two on the gantry platform at the left powerhouse and three on the gantry platform at the right powerhouse. By these several cables the structure can be drawn to its first station against the sweep of the tailrace and then shifted to any point at the foot of the spillway in order to submerge it—bring it in contact with the curved surface of the bucket. The lines will also help to moor the caisson once it is in position, but main reliance for holding it will be an anchoring A-frame. The apex of this frame will be secured to a succession of castings fitted to the face of the spillway—the tie between the two being heavy bolts that pull against powerful springs to give the mooring sufficient elasticity to react to the surge of the water.

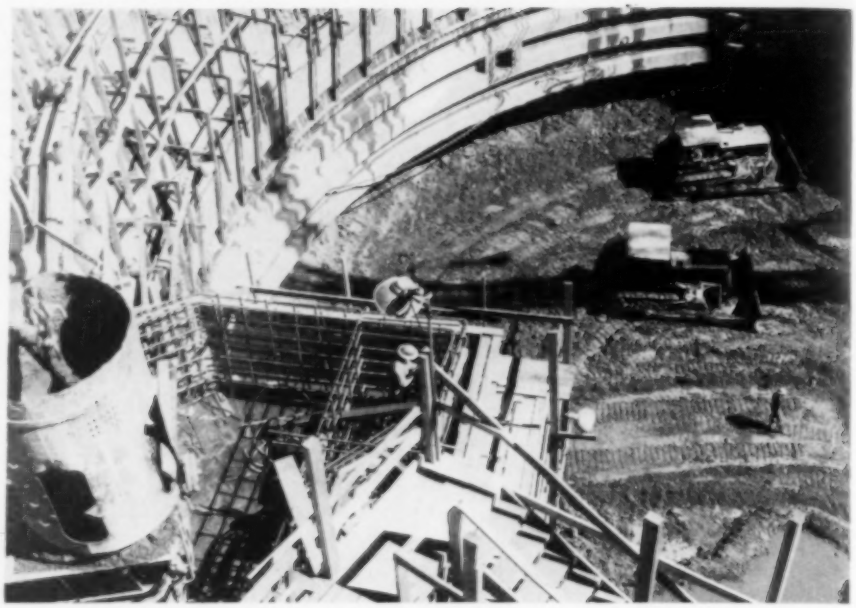
The caisson has a length of about 121 feet and an over-all width of substantially 57 feet. In a well in the body of the structure is set a rectangular barge that is approximately 73 feet long, 49.5 feet wide, and 12 feet deep. This barge is designed to float free of the caisson when the latter is submerged in the bucket, and carries hoists by which it will be capable of lifting itself above the surface of the water, if so desired. By means of another hoist installed mid-length on its deck it will control the lowering and raising of the caisson.

The vertical movement of the barge is guided by four cylindrical steel shafts —one at each corner of the well—which are structural features of the caisson. Each of these towers has an internal diameter of 7 feet 6 5 inches and a height slightly in excess of 60.5 feet. The maximum downward movement of the caisson below the deck of the barge will be 53.5 feet. The caisson will be used during the low-water season, which covers the period between October 1 and April 1; and, with its associate barge, has been developed to meet all likely conditions that may confront the en-

gineers and the maintenance force at Grand Coulee.

As accompanying drawings show, the bottom of the caisson conforms to the cross section of the bucket and its downstream lip. To the lower edges of the vertical sides and ends are to be secured rubber flaps or seals, and these will make the caisson watertight as it rests against the supporting concrete. But should leakage occur after pumping out has started, then divers will have to be sent down to make such temporary water stops as may be needed to control the inflow.

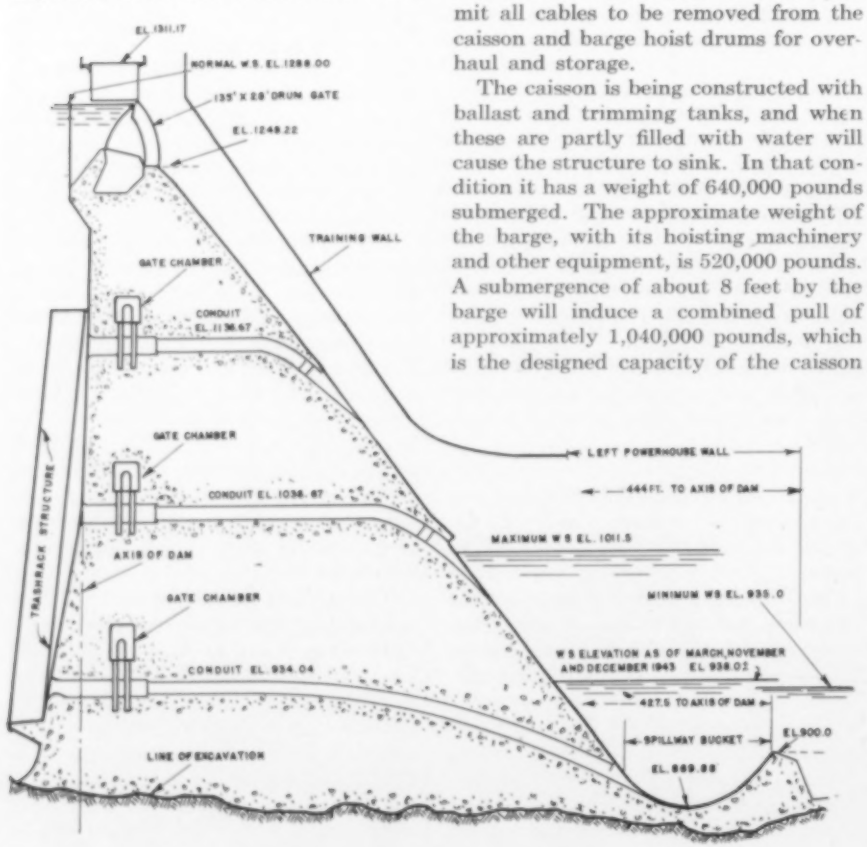
When the structure has been unwatered, the spillway basin will be accessible through any one of the four shafts. One shaft is equipped with an elevator and an emergency ladder; two are each provided with an emergency ladder, pumping facilities, and space for delivering concrete; and the fourth shaft serves for the raising and lowering of material. After the cleared area has been repaired, the caisson will be raised to the surface, drawn along above the bucket to the next working site, and again lowered. This procedure will be repeated as often as may be necessary, and the season's operations may extend over a number of weeks. At the conclusion of the work the structure will be pulled back to the dry dock under the control of the maneuvering cables, the gates will be closed, and the dock unwatered. This will permit all cables to be removed from the caisson and barge hoist drums for overhaul and storage.



INSIDE THE DRY DOCK

As the huge cylinder of reinforced concrete was built up, bulldozers and buckets excavated inside of it and aided in sinking it through sediment to a firm seat on bedrock. The structure has an internal diameter of about 160 feet and is equipped with a wide miter gate.

The caisson is being constructed with ballast and trimming tanks, and when these are partly filled with water will cause the structure to sink. In that condition it has a weight of 640,000 pounds submerged. The approximate weight of the barge, with its hoisting machinery and other equipment, is 520,000 pounds. A submergence of about 8 feet by the barge will induce a combined pull of approximately 1,040,000 pounds, which is the designed capacity of the caisson hoist carried by the boat. When filling the well of the barge, the maximum permissible head of water on the bottom of the craft will have to be limited to about 7.5 feet.



SECTION THROUGH SPILLWAY

Note the outlets at three levels and the maximum and minimum elevations of the water from the bottom of the stilling basin at the downstream side of the structure. The bucket is novel in form and was designed to rob the spillway discharge of its battering, wearing impulse.

Because of the turbulence of the water at the foot of the spillway both sets of hoist ropes will be kept taut all the while. When lowering the caisson into place on the spillway bucket, the barge hoist will have to wind the ropes under a light pull. On the other hand, while the caisson is being raised to the surface of the water, the hoist will pay out the connecting ropes under moderate stress. It should be understandable that the reciprocal movements between barge and caisson must be nicely coördinated at all times because of the very disturbed water in which these associate structures have to operate. Provision in the form of electric control equipment is counted upon to prevent mistakes by the working crew.

The floating caisson with its barge is not an emergency plant conceived only after erosion was found to have occurred in the spillway bucket. The need of it was foreseen, but its construction was purposely delayed until after the dam had been in service long enough fully to evaluate what would be required and then to work out the details. The stitch is now being taken, and in time to save the traditional nine.

This unusual and important work is going forward under the direction of Commissioner H. W. Bashore and the immediate supervision of engineers of the U. S. Bureau of Reclamation.

COLOR IS POWER

George D. Gaw*

Psychologically, red is highly stimulating, yellow less so, blue is cool and calming. Symbolically, red stands for fire and danger, yellow is associated with joy and sunshine, blue often signifies respect and order. Yellow is strongest in visibility, red is good, blue is weakest.

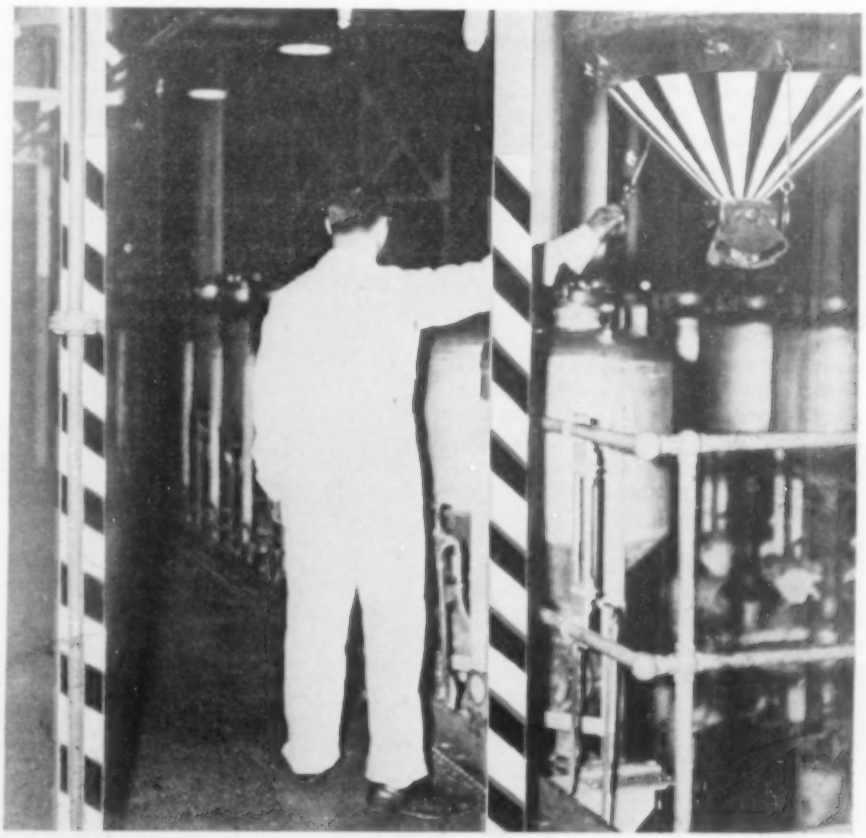
ALTHOUGH the words *red, blue, yellow, green* have some generally understood meaning, they do not actually present specific values because there are a great variety of red values and yellow values and blue values. At the best, names—even those of basic colors—are generalizations. The psychological power of a color is predicated by its exact hue. The effect from a cold red (red and blue) is very different from that of a warm red (red and yellow), while a green-blue will not affect us the same as will a purple-blue.

Red is the most stimulating of colors and is loved universally. Children, primitive peoples, the cultured and sophisticated are all animated by it. Dislike for red is a psychological abnormality caused by some unpleasant childhood experience associated with that color. Red is not, however, good for persons who are easily excited. It is most beneficial for those of a morose or melancholy temperament. A much greater number of people are being stimulated by red than by intoxicating drinks, but because the color produces that psychological effect without going through the digestive system we are not conscious of the stimulus.

The power of red to restore mental distress is brought out in the case of a well-known business man who had serious reverses. His great financial losses had affected his mind, and he was taken to a psychopathic hospital. Having refused to touch food for many days, he was placed in a red room. In less than 24 hours the patient called for food. His melancholia soon departed and he returned to normal life. Another interesting example is that of a noted woman journalist who is addicted to attacks of melancholia. When she begins to feel the symptoms she goes into a room decorated and lighted with red. After spending some time there she is ready to resume normal activity.

Further proof of the effects of red to stimulate is exemplified by the experience of a well-known hostess who was out of ideas for interesting parties for which she was noted. A color specialist told her he could prescribe something that would assure her a most successful evening provided she promised not to serve alcoholic drinks the first two hours. She reluctantly agreed to follow his instructions and put magenta lights on every fixture in the house and placed a number of them under the furniture. Result: the party was a great success, although drinks were not served at all; and the hostess also reported that husbands were making love to their own wives and wives to their husbands. The reason, of course, was that magenta is stimulating and also flattering to the complexion. Perhaps a little magenta in the home can make a major contribution to family relations.

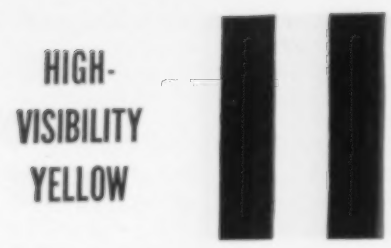
In addition to their psychological power, colors have other service value. For instance, tomato picking became a problem when experienced farm help flocked to defense plants. Tomatoes must be harvested when they reach a certain ripeness, which is determined by the redness of the fruit. The inexperienced workers available could not judge the color, and many unripe and overripe tomatoes were picked. This caused great losses. The matter was put



FOR MAXIMUM ATTENTION

Yellow has the highest visibility of any color under practically all lighting conditions. Alternating bands of yellow and black attract attention quicker than any other color combination and are used here to mark traveling overhead equipment and posts adjacent to passageways. Being such a bright color, yellow should be used sparingly and only in places where it has real meaning.

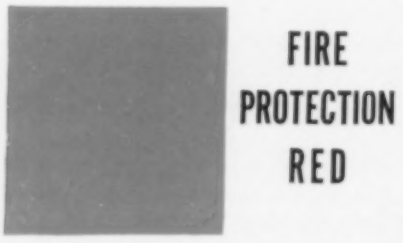
*Director, Color Research Institute, Chicago, Ill.



To mark strike-against, stumbling and falling hazards: trucking equipment, protruding parts, curbings, low beams, dead ends, platform edges, loading buckets, aisle obstructions, stairway approaches, etc.

To mark dangerous equipment likely to cut, crush or otherwise injure the worker: edges of cutting devices, pulleys, gears, rollers, the interiors of machine guards, power boxes, fuse boxes, electrical switch boxes, etc.

To identify first-aid equipment: markings over first-aid rooms, the location of stretchers, cabinets for gas masks and respirators, cabinets for medicinal supplies, safety showers, etc.



To identify fire-fighting equipment of all types: extinguishers, fire hose carts, hose connections, hydrants, fire apparatus, fire doors, alarm stations, fire blankets, etc.

SAFETY COLOR CODE

These colors have been suggested by the Finishes Division of E. I. duPont de Nemours & Company, in collaboration with industrial safety authorities, as safety signals for industry to indicate accident hazards, to identify protective equipment, and to promote good industrial housekeeping. In addition to these colors, Precaution Blue is recommended as a warning to be hung over any equipment that is condemned or out of order and which consequently should not be operated. The code also proposes marking aisles, traffic controls, storage areas, waste receptacles, and any other locations where serious hazards do not exist with the neutral colors white, gray, or black. The illustrations with this article show some of the color uses suggested in the du Pont code. Readers interested in knowing more about the subject may obtain from the duPont Company, Wilmington, 98, Del., copies of "A Safety Color Code for Industry" and "The duPont Piping Identification Color Chart."

before the agricultural department of Purdue University, where Doctor Short solved the difficulty by preparing a paint the color of the fruit as it should be when ripe. This was applied to the fingernails of the pickers, and all they had to do was to match the color of their nails with that of the tomatoes.

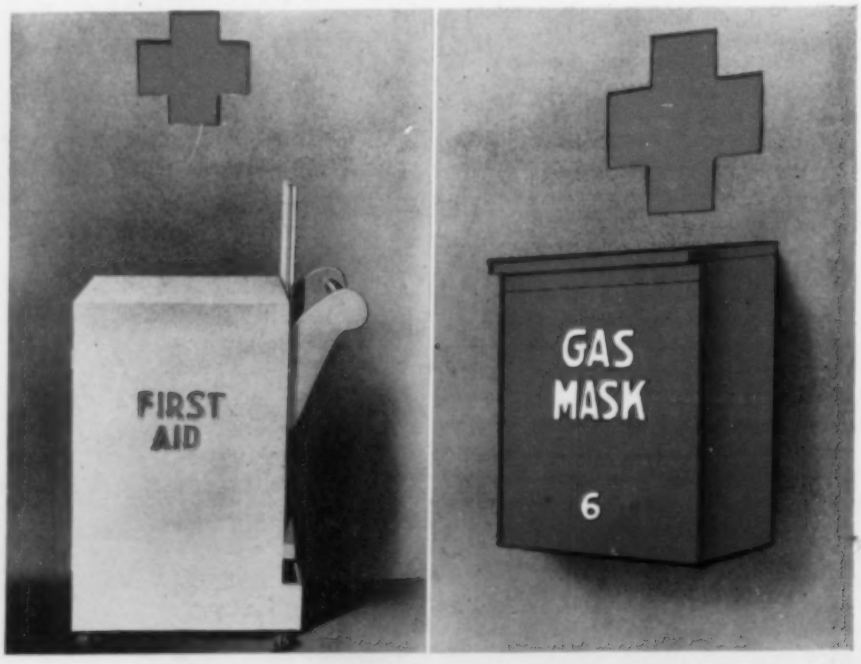
Yellow produces the sensation of sunlight, although sunlight is actually cold because it reaches us through the blue heavens. The psychological reaction to it is therefore not as positive as that to red or blue. Yellow needs most careful handling because the least variation in color value will render it cold or warm, soothing or aggravating, and thus alter its psychological character. A slight change in red does not alter its psychological power as much.

There are just as many case histories of the effect of yellow as of red. A building in a New Jersey community, for example, was painted a certain yellow that the residents claimed made them ill. They asked the owner to change it, and when he refused petitioned the City Council to force him to remove the sickening color as a health measure. Yellow is particularly unpleasant in a fast-moving, swaying vehicle such as an airplane. It was found that a cabin finished in yellow gave the passengers indigestion and caused vomiting. When that cabin was repainted a cool green, the digestive disorders were reduced more than 50 percent.

Yellow has the best visibility of all the colors and plays an important part in accident prevention. Yellow and black are the most effective combination for visibility, although black and white stripes are still used for marking dangerous points. This, however, is not the best way of preventing accidents, because white and black stripes have a tendency to blend. Surfaces so covered appear gray at a distance at which yellow and black stripes remain distinct.

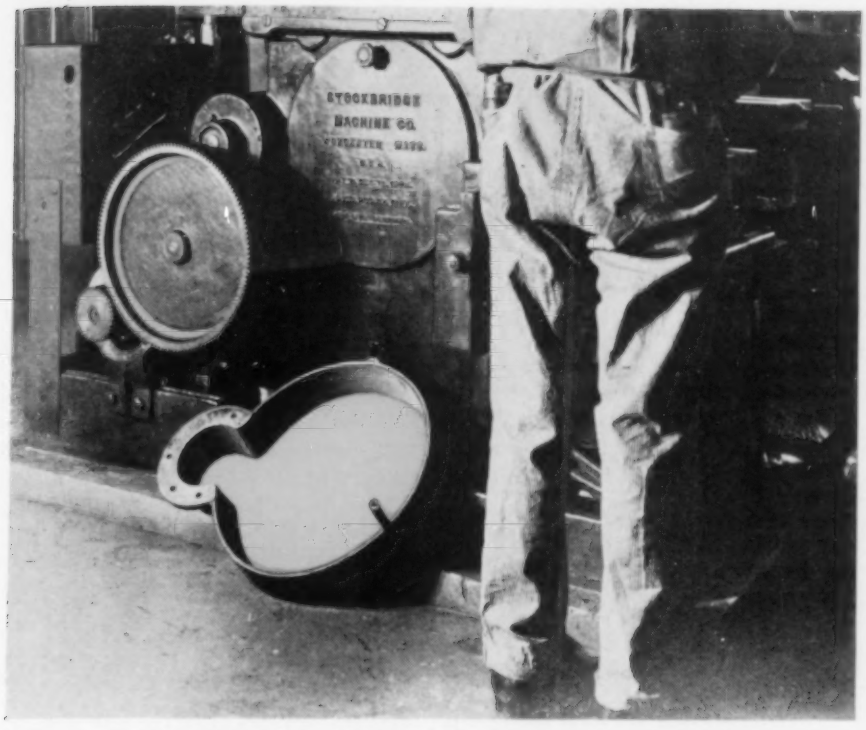
Blue is the coldest of the colors. It is a psychological sedative for persons who are disposed to being overstimulated. It is calming for most people; but on the morose or depressed individual it has a negative effect. Those addicted to melancholic attacks should avoid it and surround themselves with red, which has curative powers and makes normal people cheerful and alert. A famous football coach, in fitting up his players' dressing rooms, chose a soft, restful blue for the one in which they lounged and relaxed. But for the room in which the pep sessions took place he used red.

Of course, colors sometimes produce physical reactions that are not easily



APPLICATIONS OF SAFETY GREEN

Safety Green can be readily seen from all areas of a room and marks the location of equipment that may be needed in an emergency.



TO INSURE REPLACEMENT OF COVER GUARDS

The exposed gear wheel and the inside of the protective guard that belongs over it are painted Alert Orange as a warning that an extreme hazard exists and to draw attention to the fact that the guard should be replaced.

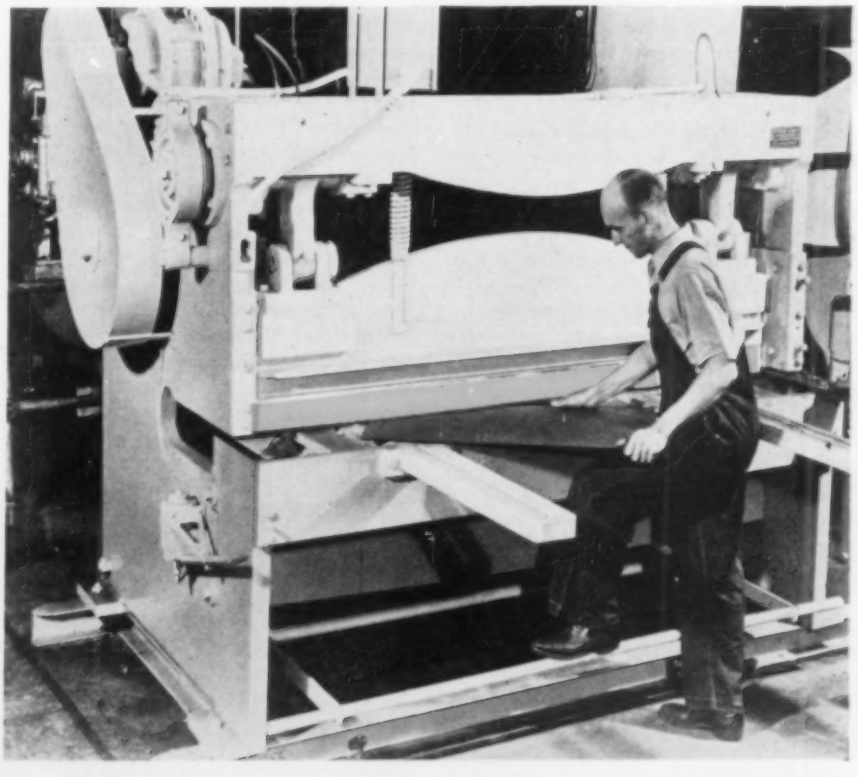
traced to them. We have frequently heard people say: "This color makes me sick," or, "I just love that color." But more often than otherwise the system is acted upon by color power without the person being aware of it. A cafeteria in a large industrial plant had warm neutral walls that were changed to blue during the annual cleaning. Dozens of complaints began coming into the office that the room was too cold, but the plant engineer knew that the temperature was the same as before. A new coat of paint was applied—the blue became orange. The chairs also were given orange covers. Customers then complained that the cafeteria was too hot, although the temperature still remained unchanged. When the orange chair covers were removed, leaving the walls as they were, the temperature was satisfactory! A visual sensation had produced a physical reaction: the diners saw blue and felt cold, they saw red and felt hot, although they were not conscious of the fact that the color was the cause of their sensations.

We speak of gay colors and somber colors, of colors that depress us and colors that give us pleasure. We have gone to places that made us feel gloomy, and we have been in others that inspired gaiety. More often than not the colors of the room were responsible for our mood, but few people know that. Most of us are not aware of the power that color has over us. The following is a case in point.

An unhappy-looking man told a color specialist, whom he knew from school-days, that his wife had the "blues," that she had hardly talked to him the last six months and had been consistently morose. He thought perhaps a visit from an old friend might do her some good. The much-worried husband had ruled out going to a psychiatrist for fear his wife might get the idea that she was insane and thus make matters worse.

The visit was uneventful. The young wife served tea mechanically and answered inquiries politely. Otherwise she did not utter a word. To the question as to how she liked her apartment, she replied that she hated it. That was the only emotional utterance she made the entire evening. Upon the visitor's departure, the husband thanked him for coming but at the same time betrayed disappointment that he had failed to rouse his wife. If anything, he seemed to have aggravated the situation with his constant questioning.

On the following day the color specialist called his friend and emphatically advised him to have the apartment redecorated and to purchase a few small accessories for it. He urged that the blue walls should be changed to a warm color with red in it—peach or a neutral orange, and insisted that the black woodwork should be painted white or ivory and that a number of pictures, ceramics of some type, vases, pieces of sculpture, all predominantly red or orange, should be added to the furnishings.



DANGER SIGNAL

Orange is psychologically the most attention-getting color and is used here as a constant reminder to the operator that the edge of the shear is a hazard to be avoided. An Alert Orange triangle or arrow can be used as a signal on any equipment on which a worker runs the risk of cutting, crushing, or otherwise injuring himself.

EASIEST TO SEE

Yellow and black stripes call attention to this overhead obstruction. Although red is often used for this purpose it is not so suitable as yellow, as it is lower in visibility value.

At first the young woman was indifferent to the alterations in her home, but in a few days she participated with enthusiasm in the arrangement of the new pieces and within a month became a normal happy wife. This case history is one of many, and is an emphatic demonstration of the psychological power of colors. The blue-and-black environment undoubtedly contributed to the woman's psychic illness, if it was not the sole cause. The red surroundings unquestionably produced the necessary stimulus towards normalcy and happiness.

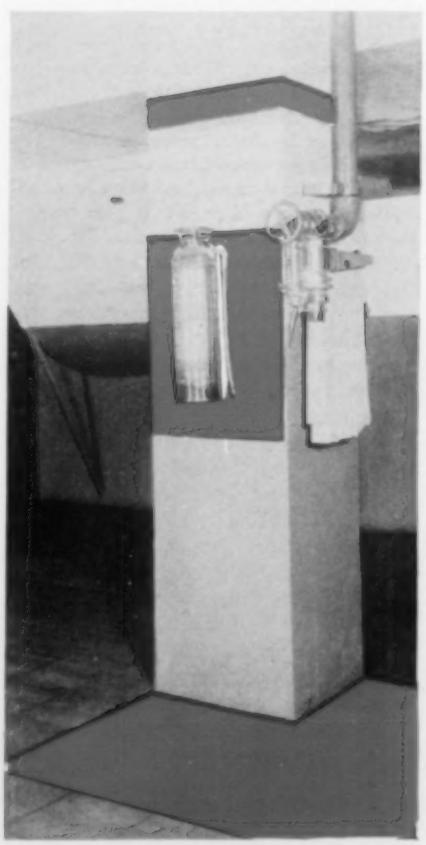
The following is a case where red had a negative effect. A young lady married a man who had a beautifully furnished apartment which she had visited on numerous occasions while they were engaged. In preparation for the mistress of the house, the prospective husband called in an interior decorator who painted the blue walls orange and made red the dominant color scheme. He wanted to surprise her—and really did. She had always been an overly excitable person, and the hot color scheme did not help her to control her temperamental outbursts. Her sudden and consistently erratic behavior was attributed to many causes. However, a change back to blue and other cool colors was followed by the return of a more rational character.

The last two examples demonstrate beyond doubt the tremendous psychological potentialities of color both as a constructive and a destructive force. They show clearly that color is a major factor in the psychiatric field. Perhaps there is a lesson in them for other husbands with troublesome wives. To the man who contemplates leaving his spouse because she is melancholic or overly nervous we say, "Change the color scheme in your home and keep your wife." Colors do not have such violent effects on most normal people because they do not react violently to any stimulus. But the case of the cafeteria, where the sensation of cold was brought about by blue and that of heat by red, is an example of mass color power.

The tremendous increase in sales resulting from the use of certain colors in advertising in all media is another proof of the universal psychological potency of color. Statistics show that a pink reply card or envelope will bring more returns than a card or envelope of any other color because pink, being of the red family, is energetic and inspires action. Orange, as has already been pointed out, is also of the red family, while purple and violet belong to the blue family and are cold, distant, and sedative in character.

Green, with which we are continually surrounded, produces the most normal reactions. In light, green is a primary color; in pigment, it is a mixture of yellow and blue. Subconsciously we associate it with nature, growth, food, and health and it is therefore pleasing and invigorating. The Black Friar's Bridge in London became known as Suicide Bridge because many people took their lives there. The authorities decided to have the structure painted green. After that was done, suicides decreased more than half. Whereas black strengthened the desire to die, green called forth life and often counteracted the morbid wish to die.

In the home, pure colors can be taken only in small doses. It would be overstimulating for normal people to live in a room of pure red and depressing to spend long periods in a blue room. For interior application on walls and other large areas, colors are therefore diluted with white, pure colors being used only as accents on small objects or spaces. The psychological reaction to colors is very much like the physical reaction to drugs. Like the latter, they should be administered in the right doses. In both cases there is danger of overdosing or of weakening the application. The mixture of white with color is analogous



FIRE-PROTECTION EQUIPMENT

The location of this fire-fighting apparatus is apparent from all directions because of the red band painted entirely around the pillar on which it is mounted.

to diluting internal medicine with water.

We are aware that the sun promotes health and growth, and we know that sunlight has through the ages been symbolic of life and that darkness meant death. Not very many years ago we learned that the sun also is the mother of color. Color is light. Where there is no light, there is no color. White light is a mixture of all the colors. Black is the absence of colors. When a surface reflects all colors equally we see white. When a surface absorbs all colors equally we see black. Most things in nature are neither pure black nor pure white because they partially reflect and partially absorb color. The color of an object is the reflected part of the light. When an object is red, it means that its surface has absorbed the other colors from the light. Colors, like sounds, are transmitted through wave lengths. Chemists are evolving hundreds of colors. They work with organic and inorganic materials and produce compounds that reflect and absorb light in varying wave lengths.

Like air and water, we use color every day; we have it before us every waking moment. We demand color on the walls of our living quarters and on our furniture. We purchase colorful rugs and paintings for our rooms. Yet we rarely realize how much color does for us or to us. Many people have distinct preferences. Some choose blue as their favorite hue, others yellow. Many prefer green, and most people like some shade of red. Generally, we go no further than personal preference in our pursuit of color. We usually take it for granted, as we do air and water.

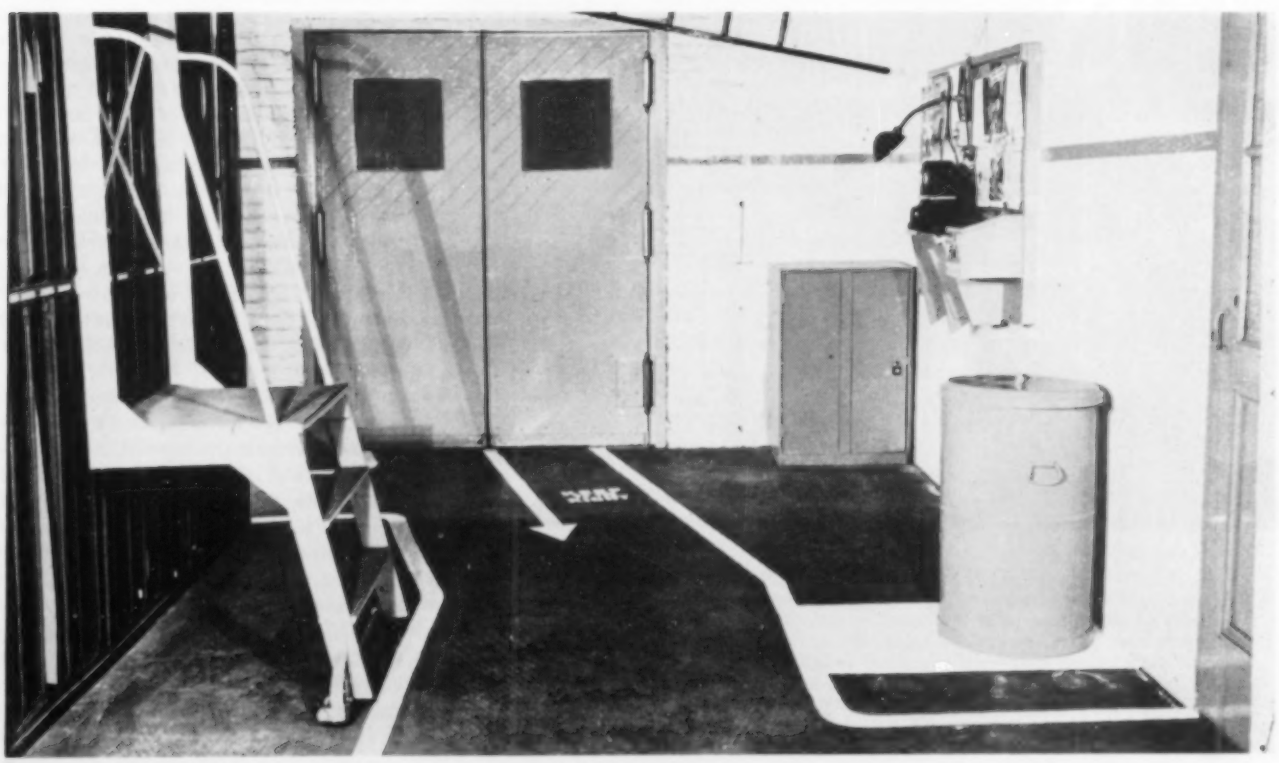
But scientists and medical men have been studying the power of color, and the Color Research Institute has been gathering all the statistics available. Knowing that the sun promotes life, growth, and heat, they have sought to determine what colors—the components of sunlight—promote? Surely if man's life is predicated by sunlight, colors must have an effect on man's well-being.

On the strength of scientific analyses and statistical data we have learned the basic nature of each color. The primary colors are now easily analyzed, but subtle mixtures present a more complicated problem. The primary hues and secondaries, which are mixtures of two primaries, can be designated by a common word description such as red, blue, violet, orange. However, such designations become meaningless for colors that consist of more than two hues and black and white.

In pigment, the basic colors are yellow, red, and blue. This means that from these three are obtained all other colors. Green is derived by mixing yellow with blue; orange, yellow with red; violet, red with blue. Various shades are produced by adding black, and tints are created by adding white. In the case of light, the problem is different. Yellow is not a primary color, but green is; and a warm red and a purplish-blue are the two other primaries. In paint or ink, the primary colors of light are secondary mixtures. Since light is the original source of color, the basic colors of light are the true primaries. We must combine two basic colors of pigment to get a basic color of light. Yellow-green, orange-red, purple-blue are secondaries in pigment, that is, each is a mixture of two colors. Actually, these are the primary colors of light.

Color planning for modern industry embraces, in addition to the psychological factors, the symbolic values and the visibility aspects of colors. The symbolism that colors have for people is important. We associate red with danger, green with nature and safety. This association has become part of the subconscious mind. Confusing visibility with legibility is one of the common errors made in color usage today. In direct-mail advertising and in magazine ads, in all types of advertising where ink is required, legibility is of first consideration. In the machine shop, industrial plant, or on the highway—anywhere where paint is used for accident prevention—visibility is paramount. The principles of color combination for legibility differ radically from those of visibility.

No color has as strong a visibility power as yellow next to black, as has



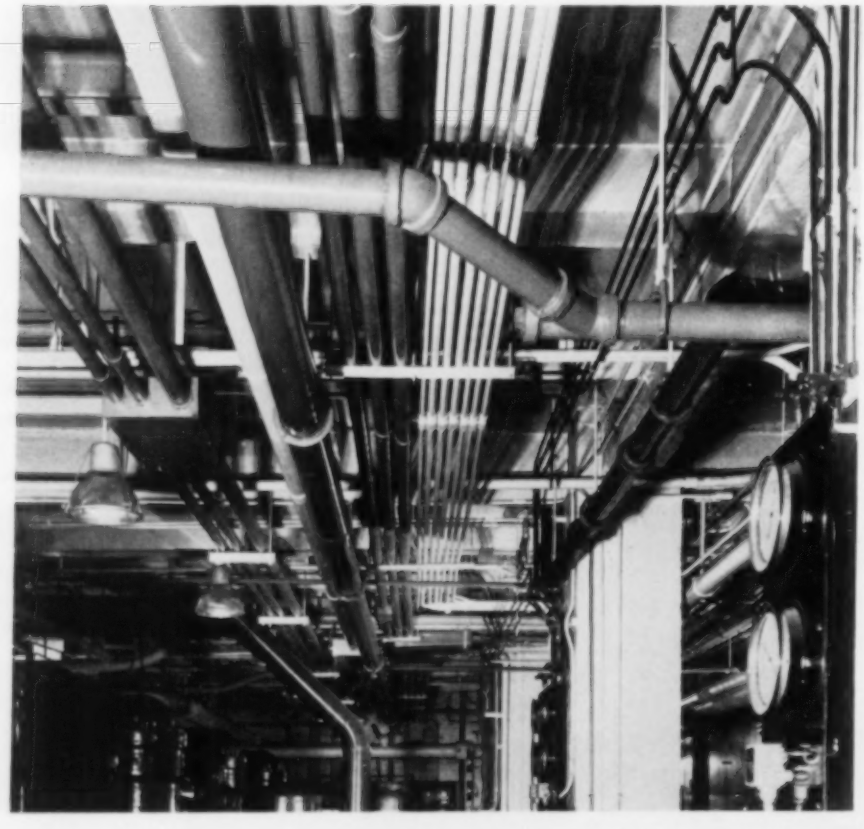
TRAFFIC MARKINGS

The white markings on the floor indicate clear traffic lanes that help guide employees around obstructions and aid in preventing collisions between persons and mobile equipment. The white area around the base of the waste receptacle discourages littering and encourages good housekeeping.

already been mentioned. Therefore, yellow and black are best where quick attention is essential and where reading at a distance is a factor. This is the most effective combination for marking highways, for designating curbings and dead ends, and for indicating hazards in plant interiors. But a yellow-and-black-striped design should be used only for visibility purposes. It should never be employed where legibility is needed because this color combination is cutting to the eyes and will not hold sustained attention.

We use red to identify fire-fighting equipment because red has long been established as a symbol for fire-fighting. However, through scientific experimentation with colors it was found that red does not have the visibility power of a warm yellow. In order to keep a man continually impressed with the fact that he is operating a dangerous machine, the Color Research Institute recommends that orange paint be applied to such a machine. Orange consists of a mixture of yellow and red and therefore has some of the high visibility of yellow and some of the danger symbolism of red. It is psychologically stimulating and at the same time subconsciously symbolic of danger.

A machine that has been treated with color is a more productive piece of equipment. When its working area, its moving parts, and the material being processed by it are of sharply contrasting colors, all the units can be easily seen. The color difference gives constant warning to the operator of the dangerous, moving parts. The colors increase visibility without glare. A black surface, on the other hand, does not reflect light and does not make for visibility, while a white surface reflects maximum light but is blinding and irritating to the eyes. And there is also the psychological power of color. Color on a machine and on the surrounding objects and walls is stimulating.



IDENTIFYING PIPING

The multiple overhead piping shown here carries fluids of various kinds. The contents of each conduit is indicated by painting the latter a distinctive color. This promotes safety, avoids confusion, and saves time. Recommended colors for main classifications are: red, sprinkler systems and other fire-protection equipment; yellow or orange, dangerous materials such as acids, gases, and steam at 212-800°F.; green (or white, black, gray, aluminum), safe materials such as drinking water, brines, compressed air, steam below 212°, etc.; bright blue, protective materials; deep purple, extra valuable materials. It is not necessary to paint the entire surface of each pipe with its distinctive color. The preferred method is to encircle it with color bands at conspicuous places, especially near valves and fittings so that they may be readily recognized during operations, repairs, and at times of emergency. The nature of the contents can be indicated by stenciling on these bands legends, either complete or abbreviated, showing what the conduits are carrying.

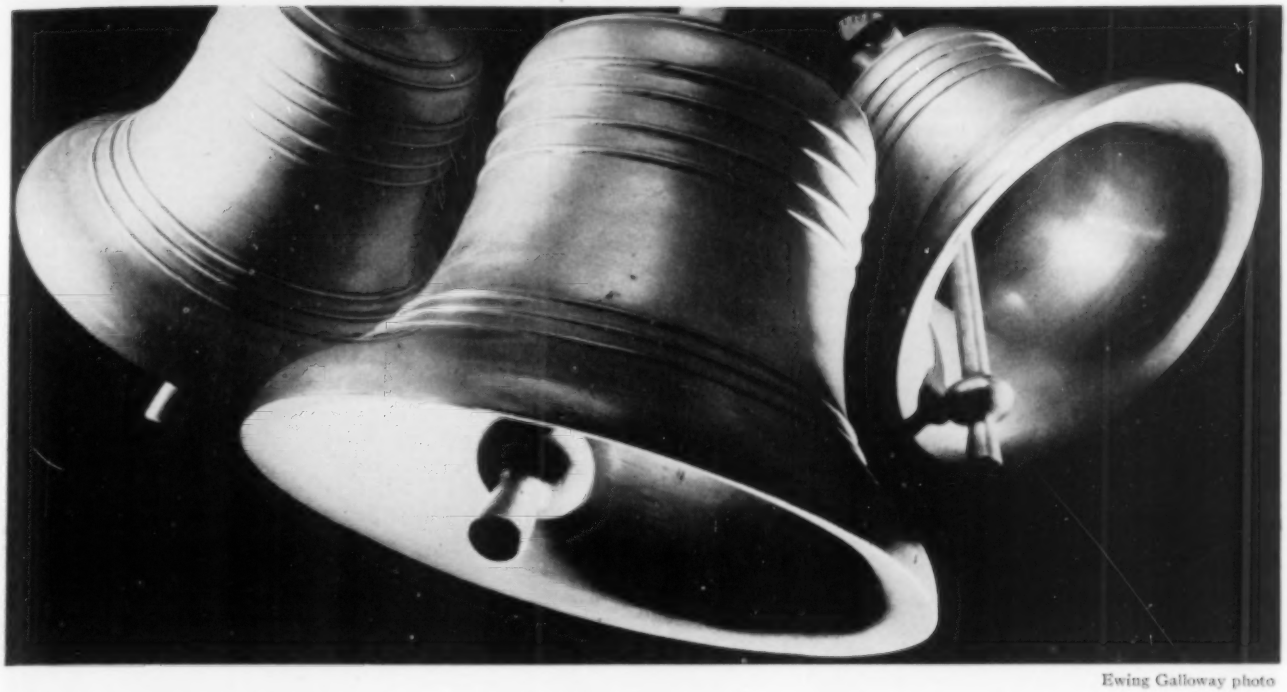
Because the lighting situation and the type of structure, as well as the kind of work being done, are major factors in color planning, each plant must be given individual study. There are, however, some general color principles that can be applied to all working places. Except in special cases, plant ceilings are painted white because this is the color that reflects maximum light. White is not used on walls because workers should be surrounded by colors that make them feel at ease and do not cause eye fatigue. The color on the walls must be in keeping with those on the machines and should be in harmony with the function of the establishment.

The old type of industrial plant with its whitewashed interior is devoid of effective danger identification, puts great strain on the eyes of the employees, causes general irritation, and results in inefficiency, an increase in the number of accidents, and lowers the morale of the workers. One interesting case history is that of a factory where merchandise packed in black boxes was being loaded into cars. The workers showed fatigue in the early afternoon and were often reporting illness. A color specialist visited the plant and suggested painting the boxes a light green. After this was done there were few complaints, and absenteeism was cut down. Reason: black is depressing and heavy, green is cheering and inspiring.

A plant that is tuned with appropriate colors is psychologically conducive to work and provides correct visibility and maximum safety. Everything in the place—walls, ceiling, and machines—are treated with colors that aid production. Scientific application of color in an industrial plant results in more accurate and faster work, happier and less tired employees, a lower accident rate, and better labor relations. Color inspires respect, encourages cleanliness, and promotes orderliness. Color is a universal language. Peoples of all nations and of every race are affected by color by reason of the fact that color sensation is instinctive.

We have seen the great power of color in selling. We have multitudinous case histories demonstrating the tremendous psychological effect color has over people. When colors are used unscientifically they have little meaning and often have harmful results. But color that is planned, color that is applied for a purpose, is of the greatest value to us.

Color tells us to go, and color tells us to stop. Color causes eye strain, and color brings eye relief. Some colors say danger, others say safe. Color soothes or stimulates, and color irritates or screams. Color is power. We have learned to use the earth's resources. We have harnessed water power. Now color power is being harnessed for the benefit of man.



Ewing Galloway photo

Bells of Many Lands

Paul C. Ziemke

HOW little we realize the extent to which our everyday mode of living is regulated and influenced by the music of bells. Recollections carry us back to the golden days of childhood and bring memories of the shrill, penetrating, yet not unkindly tone of the school bell that announced the beginning of a new day of study and friendly contact with teacher and fellow pupils.

Then, too, there were the more resonant and melodious tones of the several church bells which methodically signaled the call to worship and the close of the day's toil at sundown. At other times the bells proclaimed the great events in the lives of our citizenry. One day it was a joyful clamor announcing a great wedding, while on still another a solemn tolling marked the passing into eternity of some neighbor or friend.

Today, on those memorable occasions when we return for a fleeting visit to the scenes of our birthplace, the tones of those old bells strike responsive chords in our hearts as we stroll reminiscently down tree-shaded, quiet streets. Time and circumstances have effected great changes, but the familiar bells have changed not one iota. They greet us like old friends, although we may detect the new note of some later installation as it adds its melodious tone to the grand chorus that signals the advent of another Sabbath Day.

Now that we are city dwellers, chasing the mythical pot of gold at the base of the rainbow, we sometimes wonder why it is that we do not more frequently hear the many fine bell chimes that grace the towers and spires of our metropolitan churches. We recall that often of an evening in our youth, when we were miles removed from our native town, the sweet sound of its bells came to us, floating gently yet distinctly over the fields and hills. It was, no doubt, the serenity of the countryside that made those distance records possible, for in the city the varied noises of street traffic and steam and electric railways, the sonorous tooting of steamers and tugs, and the busy hum of daily life seriously affect the range of peals and chimes. In general, a bell will be heard farther lengthwise of the valley than over the hills; and on a plain, or on nearly level broad stretches, its tones carry well, but still better out across the water.

It is sometimes cause for comment that a bell of 100 or 200 pounds in an open belfry atop a schoolhouse or factory frequently has a longer range than one of 1000 pounds hanging in a church tower. The reason for this is that the small bell has a sharp, penetrating sound that is heard much farther away in proportion to its weight than the low, mellow tone of its bigger brother, the church bell. For many of us it is logical to suppose that the peal of a bell weighing 2000 pounds will carry twice as far as that of a 1000-pound bell; but of course distance is not achieved by such precise mathematical estimates because the resonant surface of the larger bell is not double that of its competitor.

Obviously, then, what we do gain in the bigger bell is the deep, majestic, mellow, and soul-stirring tone impossible of attainment in the small unit. It is size that absolutely governs musical pitch, while shape, proportion of the various thicknesses, and metals used control quality of sound. Even though we may have had no musical training, all of us are quick to appreciate the rich tones of properly designed bells, as compared to the harsh, clangy sounds of bells that are not well proportioned.

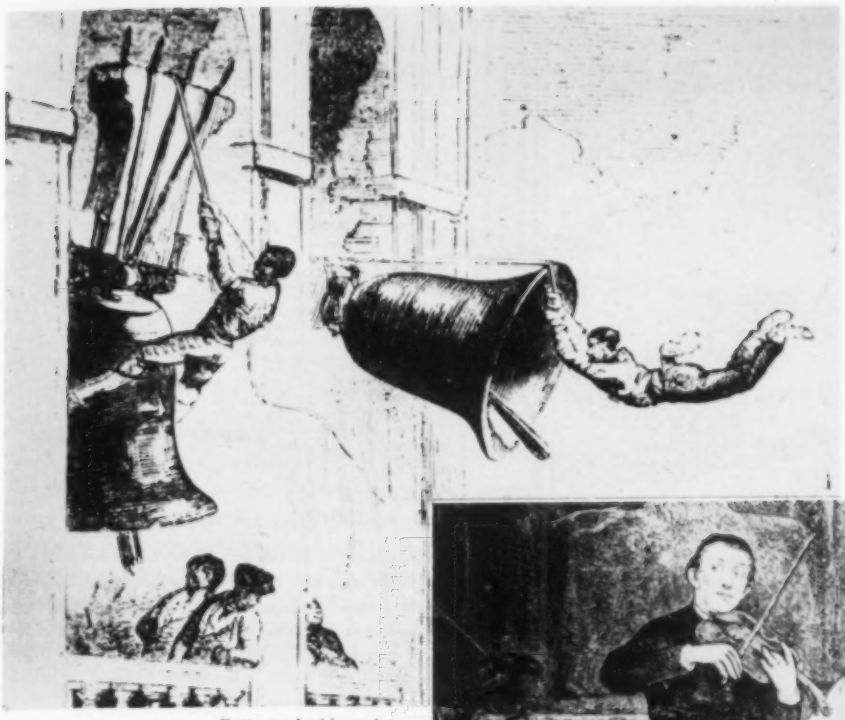
The largest bell in our home town weighed 7000 pounds. It was hung high up in the unobstructed belfry of old Trinity Church and could be heard distinctly for a distance of 10 miles on a quiet, windless evening. As a city dweller, the great 22,000-pound bell in New York's City Hall intrigued us a great deal. Often at night, when the roar of traffic in the great metropolis had subsided near the dawn of a new day, we listened to this tuneful giant, now retired from service, as it pealed out the hours over an expanse of 14 miles.

Bell sounds are concussions disturbing the air waves and are more or less melodious in accordance with the form, the empirical proportions, and the compositions of the metals employed in the manufacture of the bell. Since ancient days, founders have experimented industriously and made bells of many different shapes, thicknesses, and metals in an attempt to secure a product of superior resonance and musical qualities. However, so far nothing has been discovered to improve upon the time-tested properties of copper and tin. Therefore, it is size, shape, and proportionate thickness that give the bellsmith latitude.

RELIGIOUS BELLS

The bell pictured at the right is in Peiping, China. According to legend, a Buddhist maiden threw herself into the molten metal a moment before it was cast. One of the many Buddhist temple bells for which Burma is famous is seen just below. It is in the Shwe Dagon Temple in Rangoon. The bottom view shows the bell cot of San Gabriel Mission in California.

Ewing Galloway photos



BELL RINGERS OF SEVILLE

Instead of pulling ropes extending to the ground, these daring performers suspend themselves from short ropes and fly out of the tower with the bells. The two bell ringers compete with each other, and spectators bet on which can project himself the farthest.

TONING A BELL

Despite careful casting, a bell's tone may fall short of what it was intended to be and must then be corrected. This is an exacting task that calls for expert attention, as shown in the print, which is a reproduction of a painting made in 1874 by W. Shirlaw.

Bettman Archive prints

Even though a bell may be cast according to the most carefully calculated formulae, the tone may not be satisfactory. It is then that the really scientific work of tone-tempering is brought into play by men who have usually spent a lifetime in manipulating the tone elements that are inherent in each bell. Every one thus becomes an instrument with a distinctly pure, smooth, velvet-like tonal quality, musically attuned within itself and fully capable of producing harmonious notes either when played singly or in company with other chimes.

Usually, at least here in America, chimes consist of approximately eight bells corresponding to the eight notes of a given octave; but inasmuch as such a set would be very limited in capacity, it is supplemented by one or more bells, and these greatly multiply the number of tunes that may be played. Many airs are composed in what is known as "the key of the fourth," because the fourth bell is the keynote, and such melodies require the insertion of a "diminished seventh," termed the "flat seventh," to make the intervals in that key correct. It is the addition of the "flat seventh" and the one above the "treble" to the octave that bring the bells in the set up to ten.

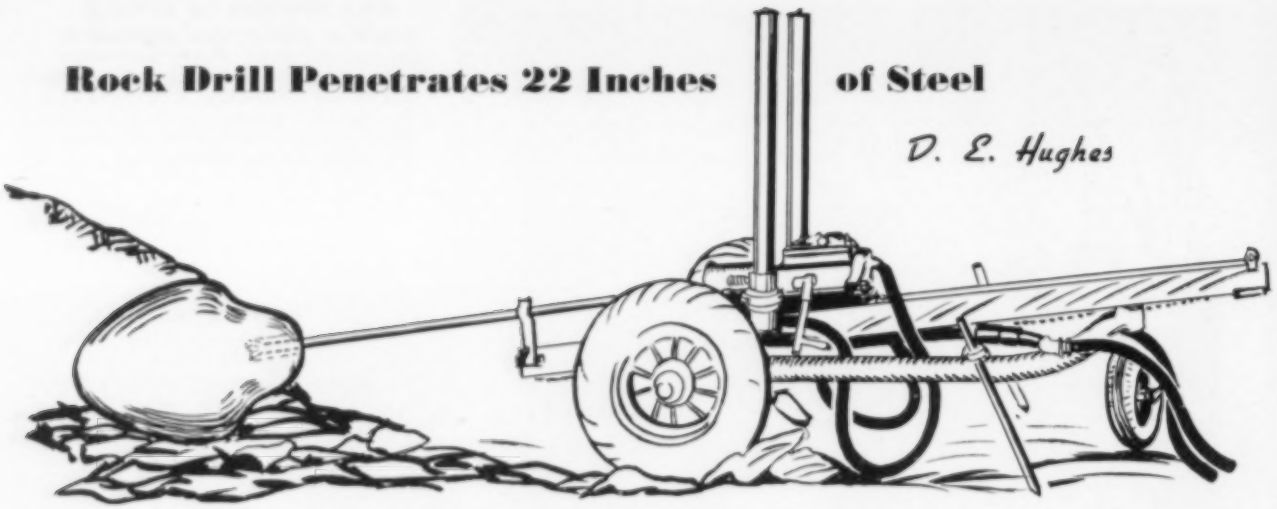
Still other tunes have what is known to musicians as "accidentals," which are often referred to as the "augmented fourth." To play these, the chimes must be supplemented by an eleventh bell, frequently called the "sharp fourth." This odd number is sometimes rounded out by a bell larger than all the rest—the "tenor"—that is ponderous enough to avoid having those above the octave so light in weight as to be without that tone-temper and musical timbre necessary to enable the ensemble to produce harmonious tones.

The original Westminster Chimes in the tower of the Parliament Buildings at Westminster, London, was composed of five bells—four quarter bells and an additional great bell the note of which was one octave below the next-largest quarter bell upon which the hours were struck. That big bell soon cracked and was recast. The second one, known as Big Ben, also cracked after a few years of service. It has never been replaced, and its use was discontinued. The clock hammers were then readjusted so the hours would be sounded on the largest quarter bell. It was soon demonstrated that the great bell was not needed, and few persons are aware of the fact that Big Ben hangs idle. Since that time the Westminster Chimes and the Cambridge clock chimes in the towers of St. Mary's Church, Cambridge, England, have only the four quarter-bell intervals. It is worth mentioning that the tones of chimes, which are rigidly supported and struck by manually operated clappers, are not transmitted over as wide an area as those of free-swinging bells, the open ends of which face in a horizontal direction while being rung by the clapper as it sways back and forth.

It is a significant fact that the melodious music rendered by bells and chimes has always been closely connected with Christian peoples, for rarely does the infidel mind associate bells with its beliefs and mode of living. Bells were not introduced into Palestine until the waves of Crusaders of medieval times invaded and gained possession of the Holy Land.

Rock Drill Penetrates 22 Inches of Steel

D. E. Hughes



SET-UP USED FOR DRILLING HOLE THROUGH STEEL WEIGHT

AS THEIR name indicates, rock drills are intended to be used for drilling rock and similar materials, but a recent instance in the West shows that they will drill even steel in an emergency. In an open-pit iron-ore mine being developed by the Utah Construction Company, a pear-shaped mass of steel has been temporarily employed to break up large pieces of blasted ore to a size that can be readily handled. This weight is lifted by a cable on a power-shovel boom and dropped on a pile of ore. It was cast by a local foundry to serve until the 48x60-inch jaw crusher ordered for the job could be made and delivered.

The makeshift crushing device worked well when first put in service, the crushed ore being moved by a bulldozer to adjacent grizzly bars and fed onto a conveyor belt extending to railroad cars on a siding. Production was halted, however, when one of the fastening lugs on the steel weight cracked off. Inquiry at the foundry disclosed that the making of a new casting would take more time than could be afforded, as a sustained supply of iron ore was urgently needed by the Pacific Coast blast furnaces to which it was being shipped.

The idea of drilling a hole through the weight for attaching the cable was suggested, but it was found that no drill press large enough to do the job was available. At this point one of the veteran construction men ventured the opinion that such a hole could be drilled with one of the FM-2 wagon drills that were used to put in the blast holes for breaking down the ore. As circumstances warranted "trying anything once," the steel ball was partially buried in the ground and the wagon drill set up as shown in an accompanying sketch.

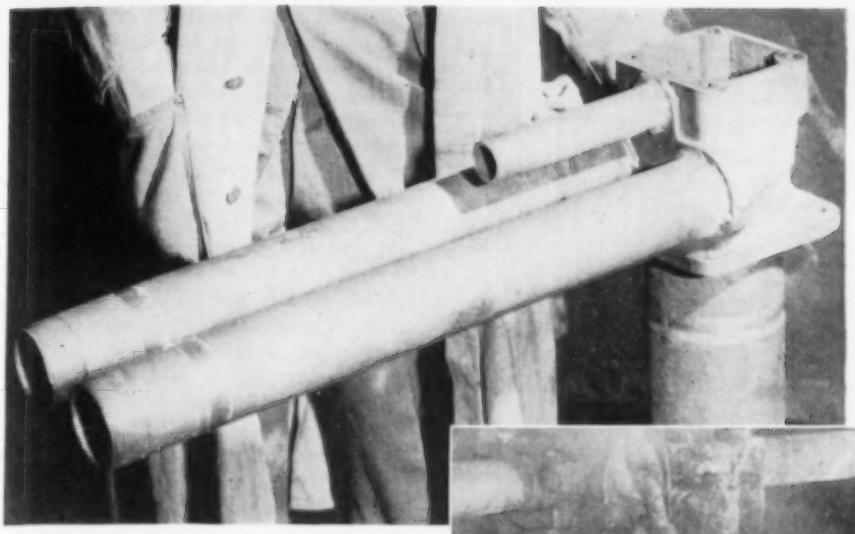
Using a starter bit of 2¼ inches diameter on conventional 1¼-inch hollow round steel, drilling was begun. After some experimenting with the heat-treating procedure to obtain the most suitable hardness, it was found that 2 inches of hole could be drilled before another bit was required. A 1/16-inch reduction in bit diameter was made with each succeeding steel change, and after six hours of work the X-71 drifter drill mounted on the FM-2 frame had penetrated the 22 inches of solid steel of 0.3 percent carbon content. Water was placed in the drill hole to keep the bit from overheating. This novel use of the wagon drill made it possible to resume crushing after a delay of less than 24 hours, and the drill went back to its more prosaic job of putting blast holes in iron ore.

VIEWS OF OPERATIONS

The picture at the right shows the floor of the open-pit mine. Blast holes put down by the three FM-2 wagon drills at work there are being charged with explosives. The blasted ore is loaded by a power shovel into dump trucks and hauled to a location near a railroad siding for crushing prior to being conveyed to cars for shipment. The steel weight temporarily used for crushing is seen above suspended from a power-shovel boom.

Submerged Air-Gas Burner for Pickling Tanks

A. M. Hoffmann



HEATS AND AGITATES AT SAME TIME

Installation view, showing one end of a 40-foot tank used for pickling bars. A section of the combustion chamber, with connecting fuel and air supply lines, is seen at the extreme right. Compressed air discharged at the bottom of the tank together with the products of combustion keep the solution violently agitated. At the top-left is the head of a 2,000,000-Btu. burner with lengths of pilot and main gas pipes and air line attached.

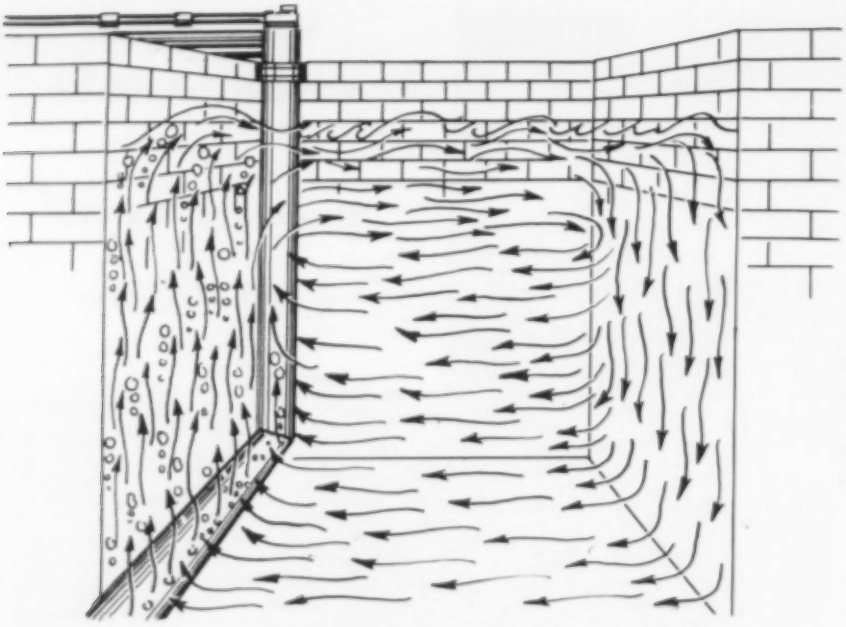
SUBMERGED combustion is a modern means of heating pickling solutions and operates on the same principle as the submarine cutting torch. In the case of the latter it serves primarily to create a pocket of air around the flame to prevent the water from dousing it, but in the former it is used not only to overcome the head of the liquid in the tank but also to agitate the bath. But we are getting ahead of ourselves.

Steam, from a central source, has long been the most acceptable method of heating pickling solutions, but by the submerged-combustion method each tank is equipped to furnish its own heat. Briefly, a gas-fired burner is placed in the vat so that the products of combustion will be directly below the liquid level where they will do the most good. The unit consists of an L-shaped tubular chamber made of varying metals to resist specific acids. One section extends down into the tank and houses gas and air pipes, a burner plate, and an igniter. The other arm runs along the bottom and is provided with exhaust ports.

The burner functions automatically, and is turned on and off by pressing a button. When shut down, the solution in the vat seeks its own level and completely fills the combustion chamber and manifold. But as soon as the operator pushes the button, a compressor starts to deliver air into the system at sufficient pressure to overcome the head of liquid in the tank, thus forcing the solution out of the burner chamber. While this is in progress, the control system begins to function. First the igniter is heated to incandescence by a high-amperage, low-voltage current; then pilot gas is caused to flow to the burner and is lighted; and, finally, the main gas supply is admitted and ignited by the pilot flame. The air-gas ratio is automatically regulated to insure a maximum of combustion efficiency, and the temperature of the bath is closely maintained by means of a thermostat.

The burner plate is located at a point in the cylindrical chamber considerably below the level of the liquid, which surrounds the housing and keeps it cool as the products of combustion are conducted down and across the bottom of the vat, where they escape by way of the ports into the solution. By this arrangement the latter is heated and at the same time agitated far more violently, it is claimed, than it could be by mechanical means. Some plants use rockers for this purpose because baths in motion clean faster and provide a more uniform pickle. Submerged combustion obviates the need of mechanical agitation, but it may be employed in conjunction with it if greater production is desired.

The air pressure used is determined, of course, by the head of the liquid to which the equipment is subjected, and in a closed vat may exceed 40 pounds, according to the Submerged Combustion Company of America, Inc. In an open vessel, however, the unit can be made to operate under pressure as low as 1 pound, provided it is sufficient to overbalance that of the solution in the vat. The



SUBMERGED COMBUSTION

The drawing shows the direct-fired burner in position, the arrows indicating the direction of the movement of the pickling bath. The rising heat and air set up an intense scrubbing action that speeds up production.

maximum pressure used up to date in a commercial application is 8 pounds per square inch.

Unlike tanks heated by steam, the gas burner consumes no fuel when not in service, and there is no loss in BTU's because the heat is generated right in the solution. Savings in heating cost of as much as 33.5 cents per ton of metal pickled are reported. However, such a high reduction is exceptional and is obtained because the plant is supplied with natural gas at the rate of twenty cents per million BTU's. Others, that have also cut their fuel bills by changing over from steam to gas, pay as much as 75 cents per million. Propane gas is being used in areas where natural or manufactured gas is not available.

From the standpoint of production, submerged combustion is also claimed to be an improvement over other methods. As an example is cited a wire-and-rod department that had to crowd five yokes of coils into a vat designed for four and to maintain the bath at a temperature of 190°F to keep machines supplied with pickled material. As a result of the conversion from steam to gas, the temperature was dropped to 165°, four yokes were handled at a time, and output was increased from 5 to 10 percent.

Temperature reductions have much to offer if production demands can be maintained at the same time. Surface heat loss at 190° is said to be nearly twice that at 160° and calls for greater heat and acid consumption, as well as for more equipment maintenance. Experience has shown that fumes rising from an open tank heated by the closed steam system carry off about twice as much acid as those from a direct-fired tank. In the case of open-jet steam heating the loss is even higher because of condensation which weakens the solution. This necessitates the addition of acid not only to make up the amount dissipated in chemical combination but also that drained off to keep the vat down to pickling level.

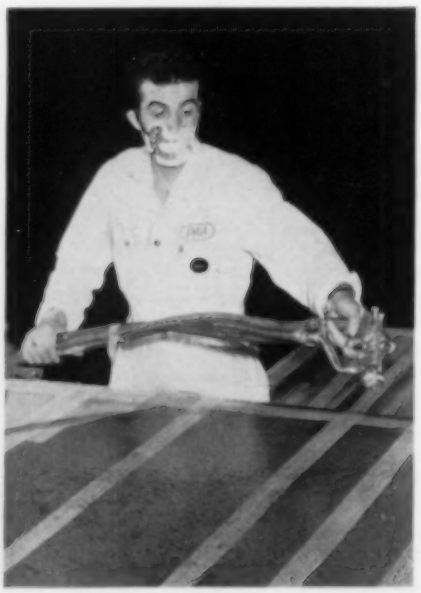
The question of acid consumption is of importance from another angle. Formerly, the spent liquor was wasted in a nearby waterway; today, because stream-pollution laws are in force in many states and because of the introduction of economical practices, the acid is usually reclaimed. Any reduction in the quantity used per ton of steel pickled is therefore of twofold advantage—it helps cut the cost of the finished product and simplifies the disposal problem.

New Spray System for Doping Airplane Fabrics

DOPE, the protective finish that serves to strengthen and stiffen airplane fabrics and to attach them to plywood plane sections, is usually applied cold by spraying. Today, through the development of what is known as the Thermotite System, the liquid can be applied hot. The equipment used consists essentially of a pressure tank, of a steam-heated reservoir, and of an air-driven circulating pump, all housed in a neat steel cabinet; of a spray gun; and of dual fluid hose lines, one to feed the dope to the nozzle and the other to return any surplus to the heater tank for reuse.

By the new method, a special full-body finish is put in the supply tank and is forced with air at 45 pounds pressure into the heater reservoir, where steam at 3½ to 5 pounds pressure raises it to a predetermined temperature. From there it continues under pressure of the air to the spray gun, any excess liquid reaching the nozzle being by-passed to the heater shell by the circulating pump. The latter is driven at approximately 200 rpm., or at just enough speed to induce the suction necessary to overcome the pressure under which the dope is fed from the supply tank.

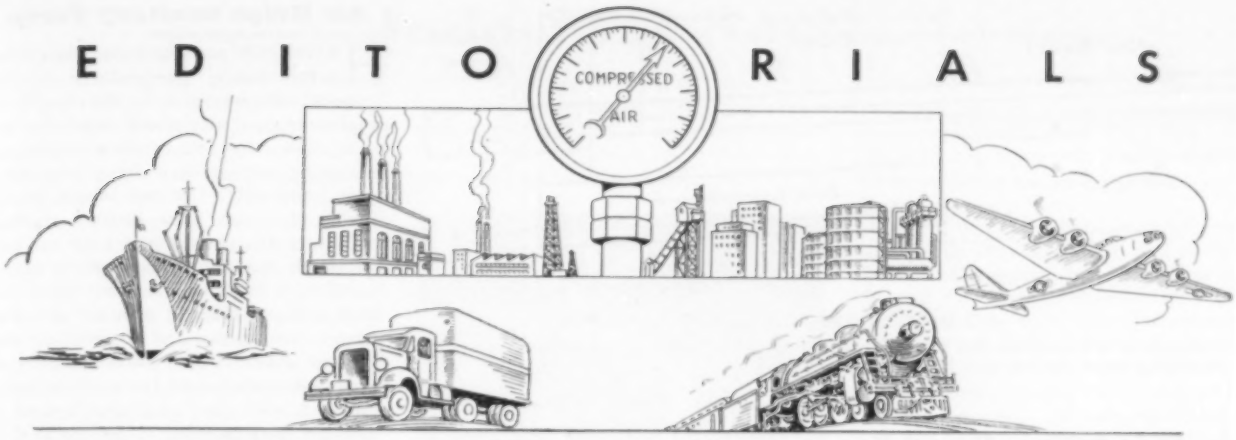
The Thermotite System eliminates the use of solvents to thin the dope for spraying, as heat changes its consistency from that of molasses to a free-flowing liquid. In addition, it speeds the work because fewer coats are adequate. It is claimed that the finishing of wing or stabilizer surfaces, for example, which formerly involved as many as sixteen operations, now requires only seven.



STRENGTHENS PLANE FABRICS

This spray gun is applying hot dope to fabric-covered aircraft sections used in the manufacture of gliders, transports, and combat planes. Heating the protective finish converts it from a viscous to a fluid consistency and obviates thinning by adding solvents. Another feature of this new spray system is an air-driven pump and a secondary hose line by means of which any surplus fuel at the nozzle is fed back to the heater tank for recirculation.

EDITORIALS



MACHINERY ON THE FARM

OUR G. I.'s have paraphrased an old refrain and are now singing, "How you gonna keep 'em down on the farm after they've seen Berlin?" Which reminds us that many of the 1,650,000 men that have been inducted into the armed forces from United States farms will never return to tilling the soil. Some of them won't be able to; others won't want to. Manpower is scarce in agricultural districts, and it promises to remain so for several years at least. Under these circumstances there is a great incentive for farm mechanization and there is a pronounced movement in that direction. One-third of the nation's farms are already adequately provided with mechanical work-savers, but these are principally the larger units. The smaller ones, the so-called "family-size" farms, must be similarly equipped if they are to be kept going.

The movement is a natural one. The machine age can be applied to farming just as it has been to industry, and that is the trend. The horse-and-mule population is dropping at the rate of 300,000 a year, but there are still thirteen million of these animals on our farms. After the war they will be replaced at a greatly accelerated pace by mechanical power. Emulating the example set years ago by Henry Ford, the Graham-Paige Motors Corporation has announced that it will build tractors and other agricultural machinery when peace comes, and other manufacturers plan to market new types of equipment to aid the small farmer.

More evidence of the movement comes from the General Electric Company, which now has a Farm Industry Division. It recently announced a control especially for 3- and 5-hp. motors which are popular on small farms. The apparatus is designed primarily for use with a barn hay drier consisting of a motor-driven blower and of air ducts that are laid on the floor of haylofts. A farmer so outfitted can cure his hay indoors, away from the damaging effects of the elements. It is claimed that the new system practically eliminates the threat of spontaneous combustion hitherto always present when hay was stored in a building. Thus, even compressed air is coming to the aid of the farmer.

SCIENCE IN INDUSTRY

HOW much are scientists worth to industry? The question can't, of course, be answered specifically—not even by all the engineers in the world using all the slide rules in existence. By putting the query in another form—How much is research worth to industry?—it becomes a little simpler, but it still is as hard as the one about whether the chicken or the egg comes first.

The truth probably is that scientists and the research they carry on are worth more to industry than anyone realizes. We can't evaluate their services because there are too many intangibles. Research, to a degree, is like advertising. Oftentimes you can't put your finger on any direct result at the moment, but both have cumulative effect and delayed action that sooner or later assert themselves.

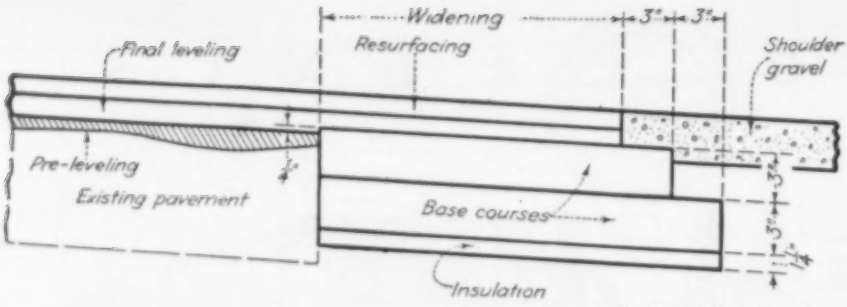
Germany could never have waged the present war or the preceding one without the aid of scientists. In World War I, the naval blockade deprived her of nitrates from Chile that were essential to the making of explosives; but she already had learned how to extract nitrogen from the atmosphere by the Haber process and went right on fighting. When the current conflict broke out, the uninformed said Germany couldn't wage another war because she didn't have sufficient natural resources. But her scientists had discovered how to make synthetic gasoline, had developed new light metals for airplane construction, and were working on jet-propelled planes and buzz bombs.

The fact that scientific research has permitted Germany to wage a world-revolting war might be construed as an indictment of research. The point is that hostilities bestir research, as is witnessed by the accelerated pace of the Allies to get abreast of Germany's accomplishments. One of the first moves in this country was to organize the Office of Production Research and Development, which functions under the War Production Board. It does not itself carry out research and tests, but evaluates, initiates, finances, and coördinates practical wartime research projects.

Great problems will face industry after the war. If our system of private enterprise is to persist, business and industry must provide more jobs at better wages than have ever prevailed in peacetime. This calls for the development not only of new fields of industry but also of new products in those that exist, and better ways of making everything. All these things come within the province of research, and it is bound to be very active during the next decade.

Today, scientific endeavor is big business. For proof one has only to consider the character of some of the recent developments. Penicillin, plastics, new glass products, fabrics from cellulose, electronics—to mention only a few. Everyone of them owes its advent to scientific exploration. Masters of science and doctors of philosophy no longer are looked upon as long-haired freaks. They are paid enough to keep well groomed and might easily be mistaken for company executives. In fact, plenty of them now sit among the so-called "brass hats."

To get back to our original question: How much are scientists worth? Frankly, we don't know, but we suspect that all the gold buried at Fort Knox is a relatively small sum compared to the returns that industry will reap from its endeavors during the next half-century. One Canadian writer, W. W. Werry, goes farther than that. Paradoxically, Germany, which almost rose to world domination primarily through the efforts of her scientists, banished many of them because they didn't happen to have pure Teutonic blood in their arteries. Most of these refugees sought a haven in the United States. Mr. Werry suggests that their efforts in behalf of our industries may more than pay our share of the cost of the war.



Courtesy, Engineering News-Record

NO SIDE FORMS REQUIRED

Procedure followed by the Ohio Department of Highways in resurfacing and widening worn paving with bituminous concrete.

Ohio Widens Paved Roads Without Steel Forms

BY REASON of a shortage of steel forms and labor, the Ohio Department of Highways has worked out a method of widening and resurfacing worn pavements with bituminous concrete that does not require side forms. Although conceived as a war measure to keep vital traffic moving fast, it has proved so successful that it will probably become standard practice. The procedure is shown in the accompanying drawing, and applies as well to brick, macadam, and portland-cement-concrete roads as to those of bituminous concrete.

The sequence of operations is as follows: If the surface of the old paving is extremely rough, it is built up by a preleveling course to the proper crown and profile before widening is started. This is done by digging a trench from one edge of the existing roadway to a point 6 inches beyond the outer edge of the added section. After it has been thoroughly compacted, an insulating course of limestone or slag screenings and the first base course of bituminous concrete are laid the full width of the trench. Next are placed, in succession, a second base course, which is stepped in 3 inches, a leveling course, and a resurfacing course. Both the latter are stepped in an additional 3 inches. The practice is to do just so much trenching a day as can be filled with the insulating and first base courses to prevent crumbling or damage by rainfall. All material removed is used to widen roadway shoulders.

Many miles of roads, mostly 18 feet wide, were so treated last year. They were broadened either 4 or 6 feet, on one side wherever possible, at a cost, in the case of the 22-foot paving, of $20,000 per mile, including shoulder gravel, drainage, berm dressing, and seeding. In addition to the economies effected by dispensing with hundreds of feet of forms, this method of resurfacing and widening offers other advantages over customary practices. According to the Ohio Department of Highways, it requires less engineering service in the matter of preparing plans and supervising field operations, and permits fast construction with relatively little inconvenience to traffic.

USE FOR OLD TUBES

At a large airplane plant in Baltimore, Md., burned-out fluorescent lamp tubes serve as molds for plastic rods. One end is broken off and the tube is then filled with thermosetting resin and placed in an oven for curing. When it comes from the oven the glass is broken and chipped off, leaving a perfect rod that requires little polishing. Rods thus formed are cut into varying lengths and used for tool handles, stiffeners, etc. The supply of burned-out tubes exceeds the demand for molds.

Air Helps Sanitary Force

HYGIENIC measures and their strict enforcement, particularly in the Tropics, are essential to the health of combat troops, and much ingenuity has been shown by construction battalions in rigging up sanitary equipment from scrap material. On one island in the Pacific the men have built a garbage incinerator from empty oil drums with the heads cut out. These were welded together in fours to form four pipes that were laid on sloping ground to assure proper combustion and to facilitate raking out ashes. One burner serves all. This is introduced at the bottom and is supplied with fuel and compressed air through flexible lines to facilitate shifting. By this arrangement any number of units may be utilized to meet requirements and each can be allowed to cool before reuse. Air at 30 pounds pressure is best suited for the purpose and both atomizes the fuel and forces the flame through the tube to effect quick incineration. The system might well recommend itself to large, isolated construction jobs.

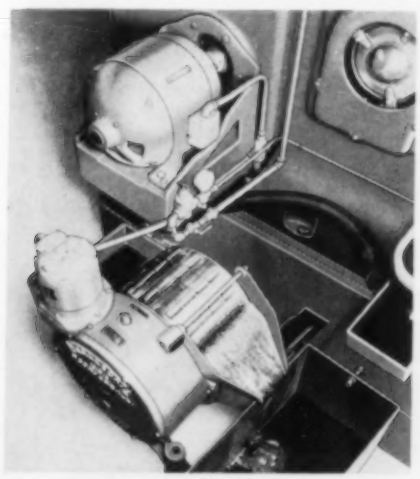
SAVES HANDLING TIME

Racks, such as the one shown, are being used to good effect in finishing and plating small airplane parts in the plant of The Glenn L. Martin Company. The mesh varies in size with the part and permits pieces to be simply slipped through or to be hung on with wire hooks. The frame is carried to and from the bath by an overhead conveyor and can be tilted either way to insure complete drainage. At no time does the operator come in contact with the solution. It is estimated that the racks have cut loading time in half.

Industrial Notes

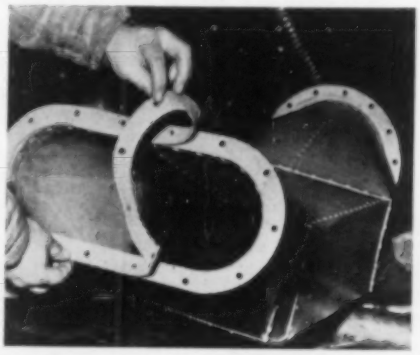
Flexrock Company makes the statement that winter weather need not put a stop to concrete work. It is offering a chemical which, it claims, creates internal heat and lowers the freezing point of the mass to 15°F. The fluid also facilitates mixing by lubricating the material and accelerates setting, producing a high, early-strength concrete.

For the removal of swarf from honing coolants with a nonsoluble base, the Barnes Drill Company has developed a separator that differs radically from equipment generally used for that purpose. It is a self-contained motor-driven unit featuring a slowly rotating drum inside of which, mounted circumferentially, is a series of permanent magnets. These attract the harmful metallic and abrasive particles entrained in the coolant, which flows counterwise in a thin, wide stream through the lower part of the separator. At the end of the cycle the sludge is scraped off and discharged by way of a chute into a removable pan,



while the coolant is returned to the reservoir in the base of the unit ready for recirculation. The separator is entirely automatic in its operation and is suitable for vertical and horizontal honing machines, as well as for grinding machines using a soluble solution, and for other similar equipment. Where gravity feed is not practicable, a motor-driven pump may be utilized to transfer the coolant into the separator. Two standard sizes are available. They are operated by a ¼-hp. motor and handle 10 and 20 gallons, respectively.

A new gasket material of wool felt impregnated with a chromate-pigmented compound is offered as a substitute for rubber by The Sherwin Williams Company. Packing of this type is said to maintain air pressures up to 25 pounds per square inch at normal temperatures; to withstand relatively prolonged exposure to salt water without decomposition; and to be highly resistant to corrosion, oxidation, and flame. In addition to these properties it is flexible, compressible, and water insoluble. Dark



green in color, chromate gasketing may be had in two thicknesses—⅛ and 1/16 inch—either precut or in sheet form for cutting at the point of use. No special tools are required for this purpose. Originally used in place of low-pressure rubber for sealing joints in marine ventilating systems and the like, it now has many other applications such as packing fire-resistant closures, refrigerator and air-lock doors, air-lock relief valves, and flange-to-flange joints in drainage, plumbing, sprinkling, water, and fuel-oil systems.

Electrodes suspended in water in elevated tanks, pressure tanks, sedimentation basins, etc., will build up a protective hydrogen film on the walls and prevent the formation of rust below the water level, says Electro Rust-Proofing Corporation. It is further claimed that, once the installation is made, the tanks never need to be drained for painting or for the removal of scale.

Under the name of Blaze-Proof Silver-Lume, The Wilbur & Williams Company is offering a paint that is said to withstand temperatures up to 1800°F. It is intended for rustproofing smokestacks, boiler fronts, furnaces, flues, and all types of metal processing equipment exposed to extreme heat in service. It can be applied by brush or spray to cold or hot surfaces and is not destroyed by direct flame.

Originally designed for patching bullet holes in aircraft, Speed Nut cover plates made by Tinnerman Products, Inc., are now serving various industrial purposes. They are being used as removable covers for inspection doors and for access and vent holes, as well as for sealing openings left after alterations or removal of equipment. They are easily attached from one side and are held securely in place by a turned-down tab once screw is tightened. Standard sizes fit a wide range of thicknesses and cover holes 29/32, 1⅛, and 1⅜ inches in diameter. Other sizes are made to order.

For the convenience of truck, bus, and automobile drivers, Ideal Commutator Dresser Company has announced a charger for its rechargeable flashlight battery. The unit may be mounted either on the dashboard or on the side panel just inside the door and is connected directly to the "live" side of the ignition system. It permits charging even when the engine is not running, and is provided with a pilot lamp that indicates when the battery is charging. The latter fits all popular 2-cell, 1¼-inch Size D flashlight cases.

In the McCook plant of the Aluminum Company of America, the use of electronic instruments in the production of aluminum sheets or skins for airplanes has successfully passed its initial test. It is reported that this system of precision temperature measurement and control has not only increased output but also improved the quality of the metal. The instruments are not affected by vibration and take temperatures at extremely high speeds. They are installed at three different processing points—from the ingot on through the slab to the sheet.

Balanced on the scales in the accompanying picture are a piece of cork and a piece of Flotofoam which was developed and is being manufactured by the United States Rubber Company. It is a combination of synthetic plastics which are foamed and then solidified, forming a material of great buoyancy and possessing good insulating and soundproofing properties. It can be made to weigh as little as ¾ pound per cubic foot.

Among the peacetime uses foreseen for the product are lifesaving equipment and buoyancy units for pleasure craft; and as an insulating material it will find application in homes, trains, airplanes, and automobiles.

It is reported that welded seams on steel tanks can be tested for tightness by spraying them on one side with Kano Kroil. This product of Kano Laboratories is described as a creeping, penetrating chemical with an extremely low surface tension. If there are any leaks in a container, they will be detected on the other side of the seams because the fluid passes through even minute openings.

Chemists frequently use the symbol pH, which means hydrogen-ion concentration, or tendency towards acidity or alkalinity. A pH of 7, for example, is neutral. If, to obtain a definite reaction, the fluid a chemist is using has to be either on the alkaline or the acid side, he varies its pH accordingly. This, we are told, can now be done simply by dosing it with distilled water in which a pill has been dissolved. The tablets have recently been made available and range from 2 on the acid side to 12 on the alkaline side.

For removing platings such as copper, chromium, cadmium, zinc, and tin from cast iron or steel, United Chromium, Inc., has produced an alkaline material named Unichrome Strip Salt. It is dissolved in water for use at 80 to 180°F. with a current density of 100 to 175 amperes per square foot. The bath is heated with steam, and steel or copper electrodes are utilized, depending upon the metal to be stripped. It can be put in an unlined steel tank and does not, it is claimed, etch or pit the base metal, which can be replated without further preparation.

Oil-Rite Corporation has recently announced an improved type of constant-level oiler for bearings and machine parts. It consists of a glass reservoir, ranging in capacity from 1 to 16 ounces, that is cemented to a collar in a metal base having an air vent and threaded openings on one side and the bottom for optional pipe-line attachment. The construction is such that when the lubricant in the base drops below the sealing level, air is admitted into the vent and above the surface of the oil in the reservoir. This action breaks the vacuum and releases just enough oil to restore the sealing level. A thumbscrew permits removal for refilling, and a spring stopper prevents spilling during replacement. The stopper is held clear of the opening when the reservoir is in position.

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Light weight simplifies handling, makes Naylor easier to install.
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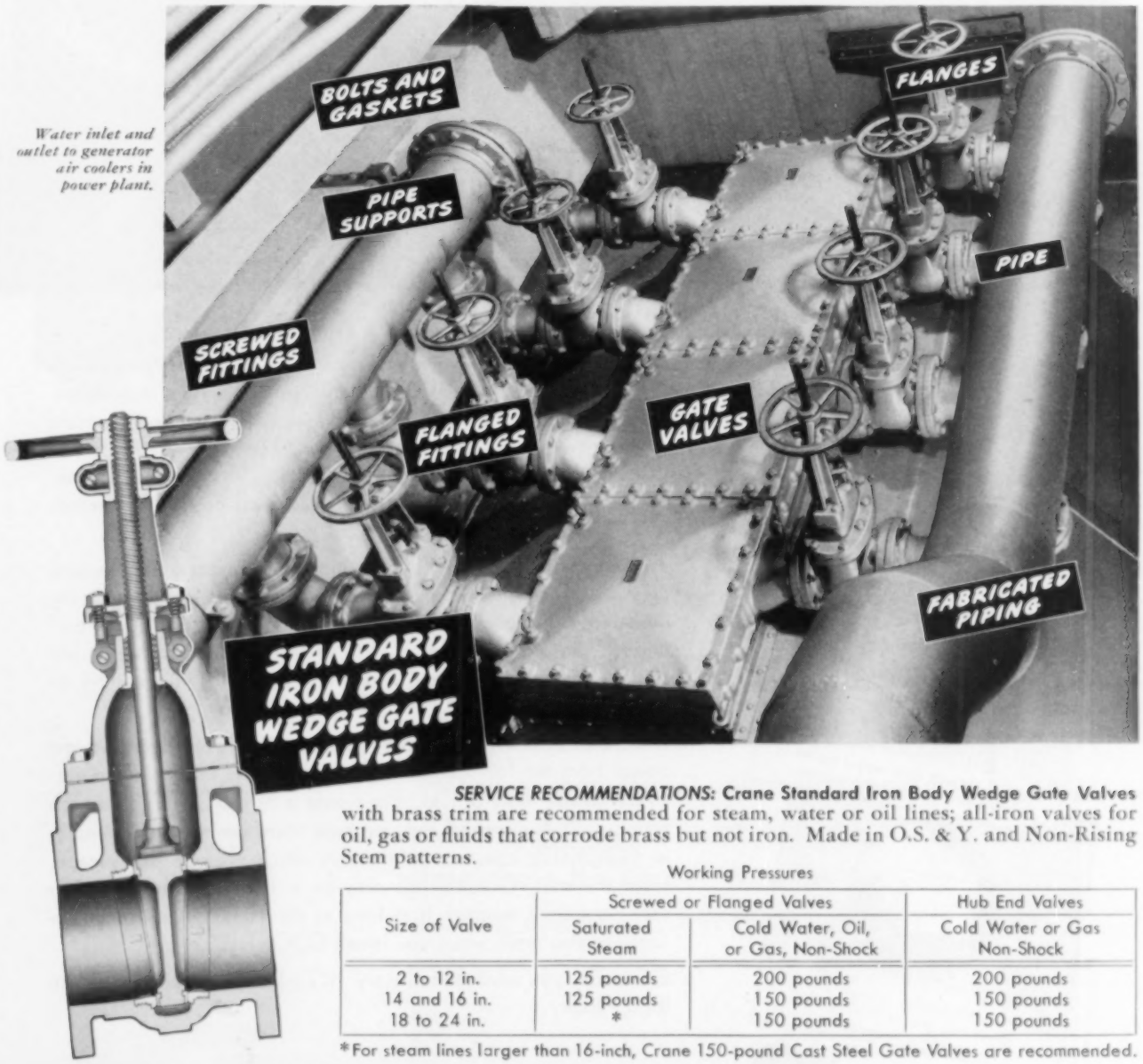
Water inlet and outlet to generator air coolers in power plant.



SERVICE RECOMMENDATIONS: **Crane Standard Iron Body Wedge Gate Valves** with brass trim are recommended for steam, water or oil lines; all-iron valves for oil, gas or fluids that corrode brass but not iron. Made in O.S. & Y. and Non-Rising Stem patterns.

Working Pressures

Size of Valve	Screwed or Flanged Valves		Hub End Valves
	Saturated Steam	Cold Water, Oil, or Gas, Non-Shock	Cold Water or Gas Non-Shock
2 to 12 in.	125 pounds	200 pounds	200 pounds
14 and 16 in.	125 pounds	150 pounds	150 pounds
18 to 24 in.	*	150 pounds	150 pounds

*For steam lines larger than 16-inch, Crane 150-pound Cast Steel Gate Valves are recommended.

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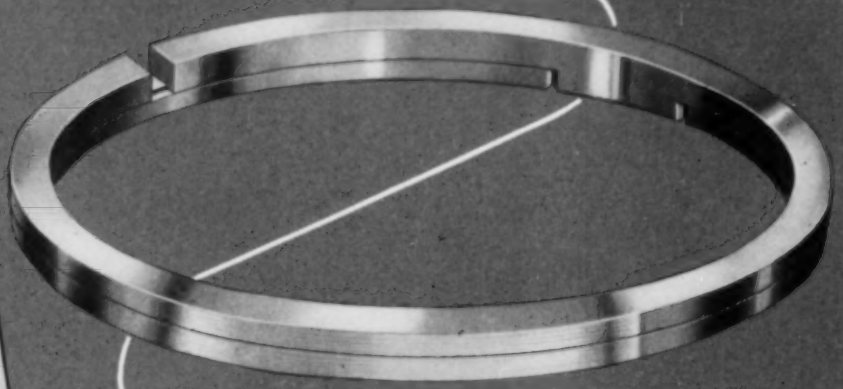
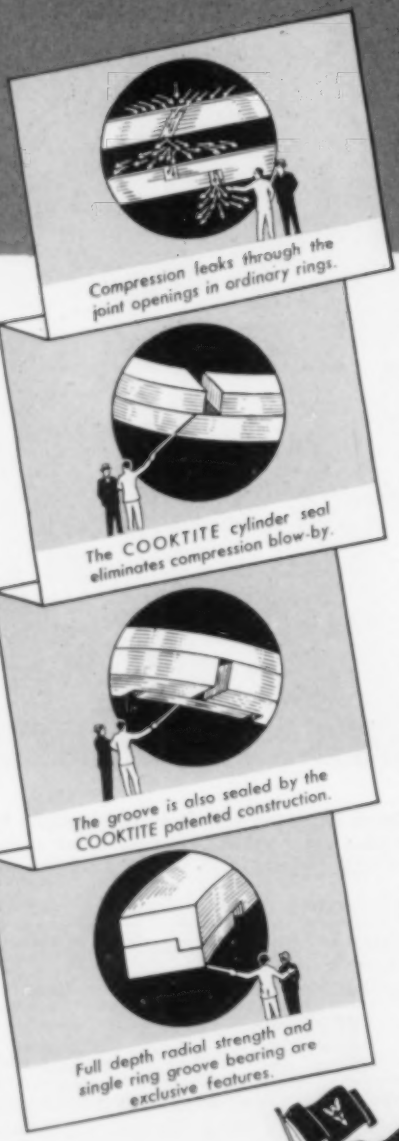


COOKTITES


Compression leaks through the joint openings in ordinary rings.
The COOKTITE cylinder seal eliminates compression blow-by.
The groove is also sealed by the COOKTITE patented construction.
Full depth radial strength and single ring groove bearing are exclusive features.

YES, by simply replacing two of the ordinary rings on each piston with COOKTITES you will immediately get more horsepower—up to 25% more, depending on your engine's present cylinder wear condition. Even if cylinders are badly worn, COOKTITES, properly applied, will restore "new engine" power. These are not just theories. They're facts, established by records of thousands of installations.

And why will COOKTITES assure increased horsepower? Because they will completely stop the leak of compression through the unsealed gap openings of the ordinary rings. True, this "blow-by" through the ordinary rings is small at first—but it accelerates fast as rings and cylinders wear, and it is a big factor in speeding up the wear.

Thus, with ordinary rings only, you continually get less and less power from the fuel burned—which, of course, means a progressively greater waste of fuel. Put a couple of COOKTITES on each piston and you end all this, because there are no gap openings in COOKTITE construction through which pressure can escape. From the start, COOKTITES provide a 100% positive cylinder seal—and they maintain it as long as they last. Many other advantages also result when you install COOKTITES.

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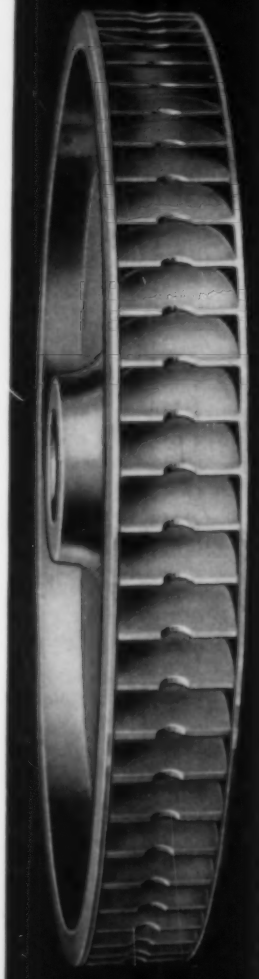
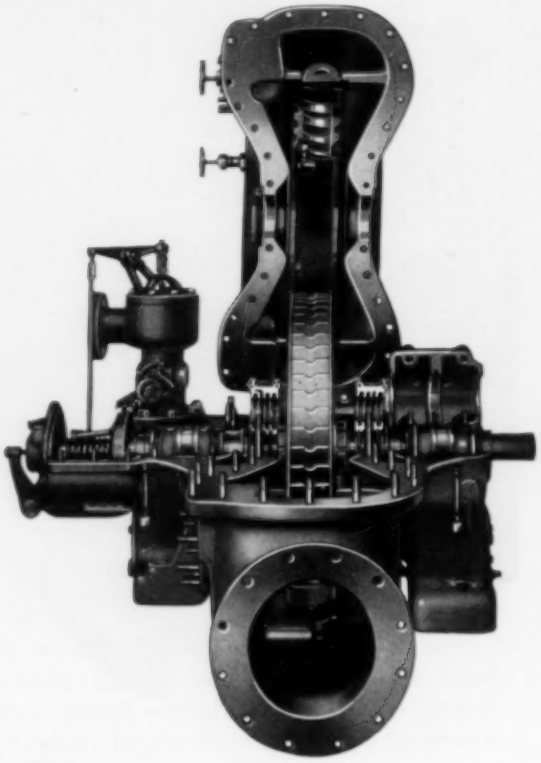


SOLID WHEEL DOUBLE-RIM TURBINES are PROTECTED



In Terry Wheel Turbines the blades are protected by rims at the sides of the wheel, which would take without damage any rubbing that might occur if the clearance became reduced.

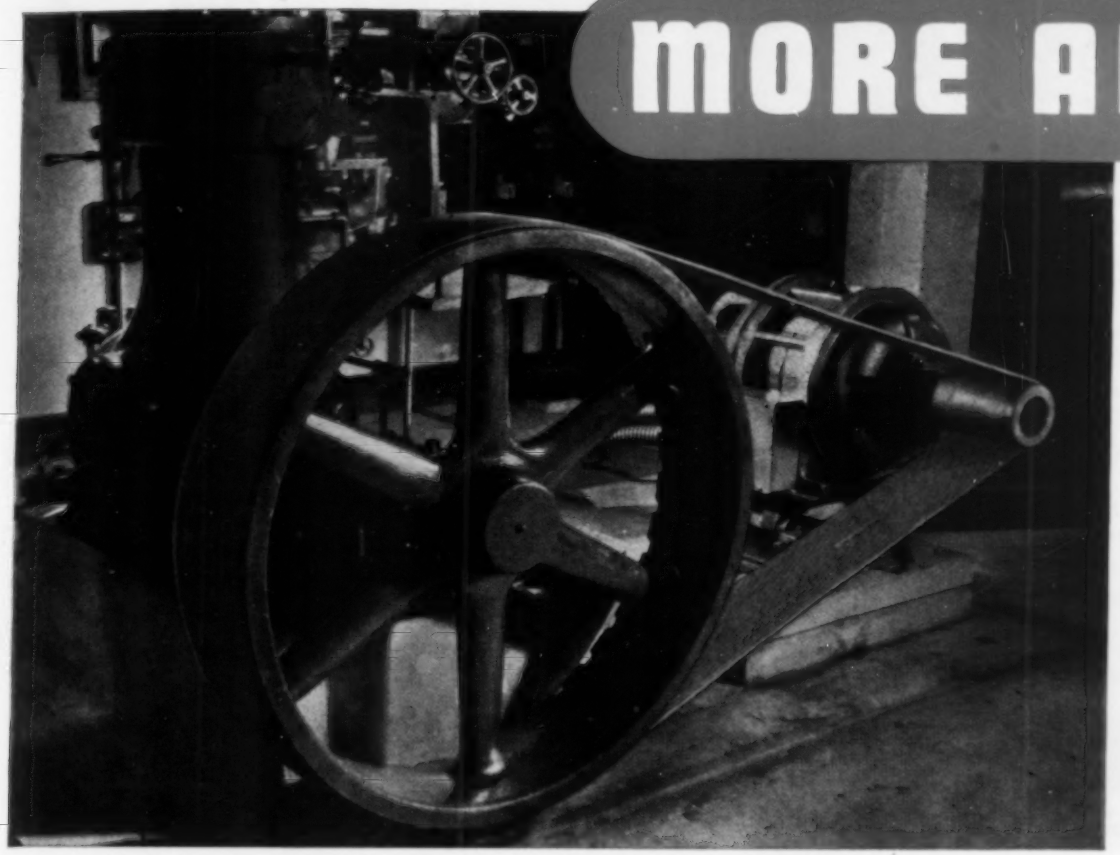
With this construction it is impossible for the blades to foul and frequent inspections of the thrust bearing are not required to obtain safe and dependable operation.

This and many other features of Terry wheel turbine design are fully described in our bulletin S-116. A request on your business letterhead will bring a copy.

Above:
Typical Terry Wheel Turbine with cover raised. Unit is rated 400 HP at 3500 RPM with steam conditions of 650 lbs.—825°TT—2 lbs.

T-1140

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.



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A drop in air pressure when it's badly needed can often be attributed to belt slippage, which in turn can be blamed on lack of proper tension.

With a VIM Efficiency Drive (VIM Tred Leather Belt on a pivoted motor base) correct tension is automatically maintained by the weight of the motor, permitting the belt to do its job of delivering full power longer and more uniformly.

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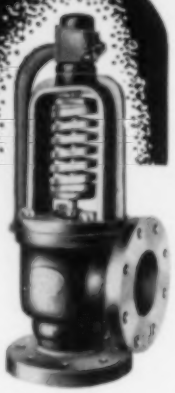

This FARRIS Safety Valve No. 2350 has high-lift disc action which secures HI-Capacity Relief . . . for HI-Pressure, HI-Temperature work. Precision machining of every finished surface secures close tolerances, precision operation.

"Precision alignment" of spring, stem, disc guides, and seat, protects this FARRIS valve against sticking and other performance-failures. Economical first-cost and very low (if any) maintenance expense.

Write today for Bulletin on our complete line of Safety and Relief Valves.

Built in bronze, cast steel, and semi-steel for pressures to 600 lbs. at 750° F. Sizes ½" to 6" x 8". Meets ASME requirements.

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SAFETY and RELIEF VALVES

You Must Have Clean, Dry Compressed Air

Partial Cleaning Isn't Good Enough!

Contamination in compressed air ups tool maintenance costs so greatly, inflicts such damage on spray-painted work and causes so many production difficulties that only completely clean air is adequate. Why gamble with air cleaning methods that effect only partial removal? The Aridifier continuously and thoroughly removes moisture, oil and fine scale from compressed air by centrifugal force. Ask for Bulletin 543.

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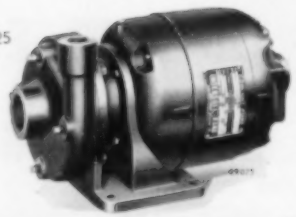
Logan ARIDIFIER
Dries and Cleans Compressed Air

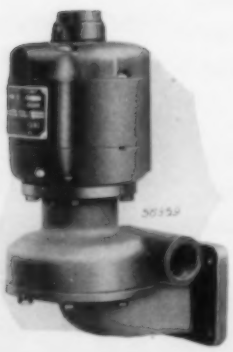
Horizontal type, 5 to 125 gmp Heads to 80 ft.



COOLANT PUMPS *help build tanks and planes*

Immersion type, 5 to 150 gpm Heads to 125 ft.

Sidewall type without seal, 5 to 50 gpm Heads to 19 ft.



Sidewall type with seal, 5 to 60 gpm Heads to 25 ft.

Coolant Pumps are vital in building tanks, planes and guns—are a necessity in the building of any machine. The weight of coolant pumped during machining operations is usually far greater than the weight of the finished machine.

Since dependability of operation is absolutely essential, Ingersoll-Rand coolant pumps are built to stay on the job. They are simple and rugged, requiring a minimum of maintenance. Ingersoll-Rand Company, Cameron Pump Division, 11 Broadway, New York 4, N.Y.

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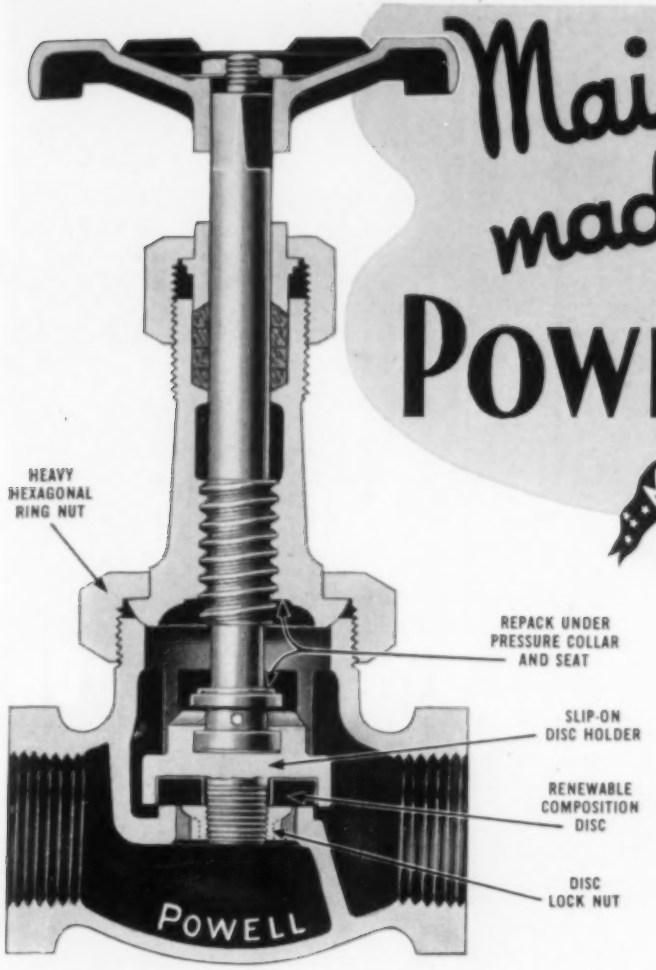


Fig. 150
BRONZE "UNION" COMPOSITION DISC GLOBE VALVE

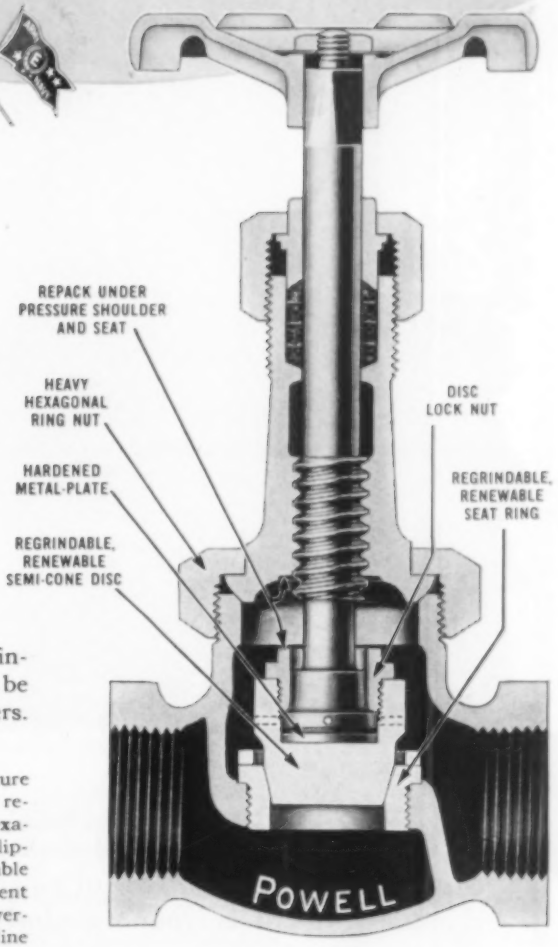


Fig. 1708
BRONZE "WHITE STAR" GLOBE VALVE

In these days of round-the-clock operation, time spent in the maintenance of equipment means a loss in production that can never be made up. If it's flow control equipment, Powell has the answers. Here are two examples.

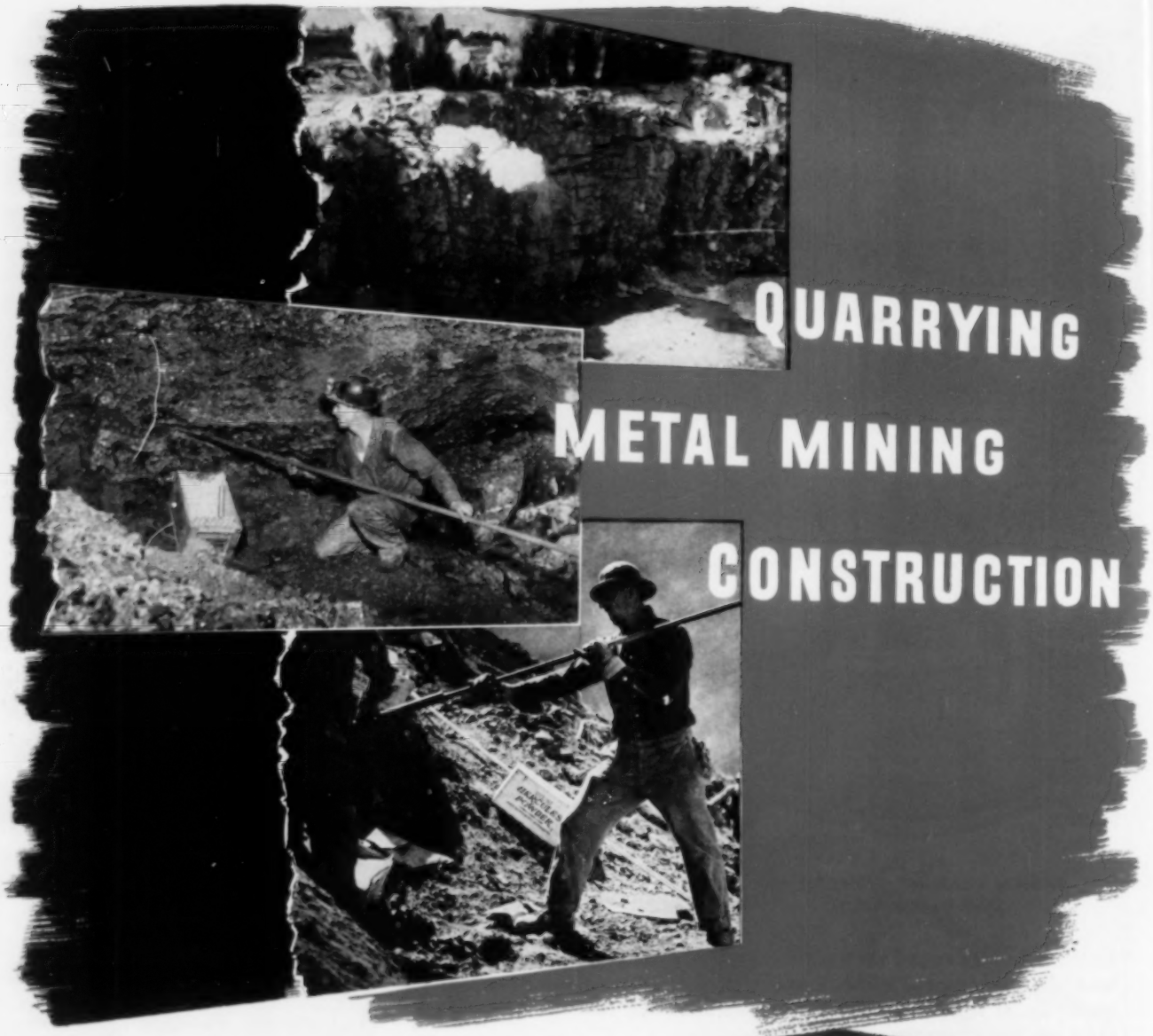
Fig. 150—a Union Disc Globe Valve—is an economical valve for low pressure steam, oil, water, gas or air. The composition disc can be quickly and easily replaced without removing the valve from the line merely by backing off the hexagonal ring nut, lifting the bonnet assembly out of the body and removing the slip-on disc holder. The discs, especially for the smaller sizes, are readily obtainable and very inexpensive. Discs of various compositions are available to meet different service conditions and the importance of using the *right* disc cannot be over-emphasized. The seat can be refaced without removing the valve from the line as indicated above.

For *extra long life*, Fig. 1708 is recommended. The seat ring and disc are made from special hard metal compositions. The hardness of the seat and disc, with their wide contact surface, tends to resist erosion and corrosion over a long period of time. Without removing the valve from the line, seats and discs can be reground to a new tight bearing and, when necessary, new ones can be easily installed. No special tools are required.

All Powell Valves that require repacking are provided with a specially machined cut-off to permit repacking under pressure when wide open.

The Wm. Powell Co.
Dependable Valves Since 1846
Cincinnati 22, Ohio

POWELL VALVES



IN quarrying, construction, metal mining, users of Hercomite* and Gelamite* are currently saving 10% to 15% of powder costs compared with older types of explosives.

Whenever their use is indicated, Hercomite and Gelamite give maximum breakage for every dollar. Proof of their efficiency and economy is to be found in their widespread use, both on the surface and underground. These high-cartridge count explosives are now more popular than ever before.

Originated by Hercules, Hercomite and Gelamite are only one example of many outstanding Hercules developments in the field of explosives.

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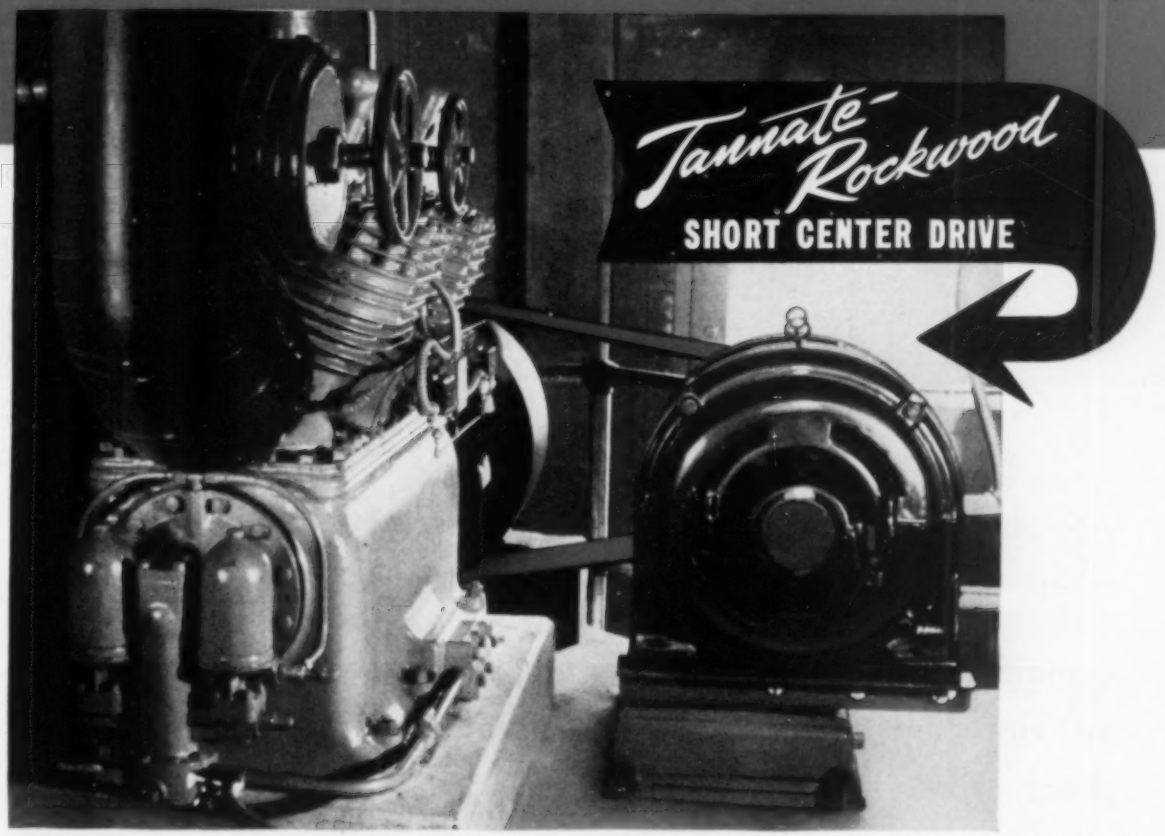
THE COMPRESSOR DRIVE THAT GIVES ALL 3 ADVANTAGES

RELIABILITY · · · LONG LIFE CONTROLLED BELT TENSION



For a compressor drive that will give really dependable, trouble-free service over a long period of time it pays to select a Tannate-Rockwood Short Center Drive. This has been proven in numerous installations of which the one shown here is typical.

The Rockwood pivoted motor base provides a simple means of establishing correct belt tension when installed and for automatically maintaining it. This is the important factor in assuring maintenance of high efficiencies at peak loads for which the Tannate-Rockwood Drive is noted.

The great strength and flexibility and unusual endurance of the Tannate Leather Belt results in a long service life with almost no maintenance.

Rhoads Engineering Service is available to help you select the proper drives . . . send us your problems.

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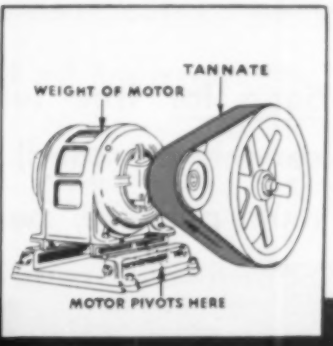
INSTALLED IN 1939

on 100 HP motor operating compressors for air conditions system . . . still running with perfect satisfaction.



RHOADS

Tannate-Rockwood

SHORT CENTER DRIVE

Insoluble in Water—Oil—Steam—Gasoline—Freon—Ammonia —and many other liquids and gases. Makes a permanent seal.

Remains plastic; does not harden with age. Joints unaffected by vibration or temperature changes; easily broken after years of service.

Smooth; easy to apply; readily fills all clearances. Non-settling. Packed 1 and 7 lbs., ready for use.

Send for free test sample (mention service intended) and see how this multi-purpose, permanent joint compound can reduce maintenance in your plant or product.

CRANE PACKING COMPANY

BALTIMORE, BOSTON, BUFFALO CLEVELAND, DALLAS, DETROIT, HOUSTON, LOS ANGELES, NEW ORLEANS, NEW YORK, PHILADELPHIA, PITTSBURGH, SAN FRANCISCO, ST. LOUIS, TULSA

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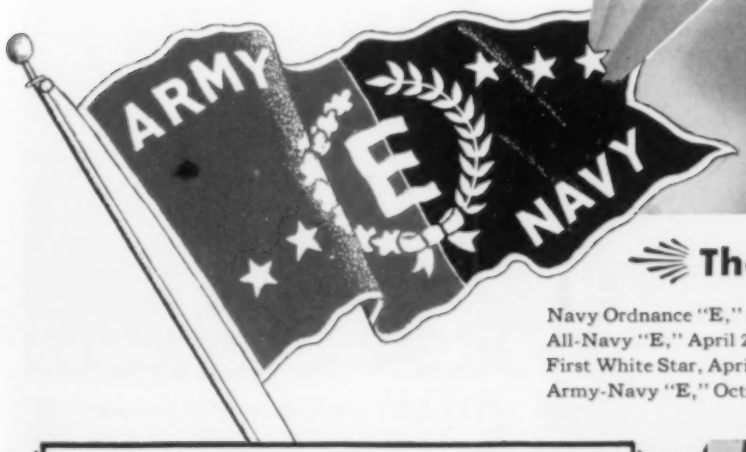
CRANE PACKING CO., LTD., Hamilton, Ontario, Canada.
Branches: Montreal, Toronto, Vancouver

America's Most Significant Production Award . . . .

the 5th White Star comes to National Forge

A "five star plant" denotes the highest possible recognition that can be earned in war material production. And like military precedent, the 5th White Star can only be earned by "coming up through the ranks"—the preceding four White Stars, as well as the basic Army-Navy "E" Awards, have to be a matter of record before a company is in line for the 5th White Star recognition. And to receive the 5th White Star, the original excellence of production has to be maintained — without interruption — for six, successive, six month periods.

The management of National Forge therefore feels it can announce the receipt of the 5th White Star award with pardonable and understandable pride . . . a pride which fully recognizes that it is National Forge workers who have established this unsurpassed record as award winners . . . and also a symbol, we are sure, that there will be no abatement of National Forge efforts in war production as long as the Army and Navy have need of our services.



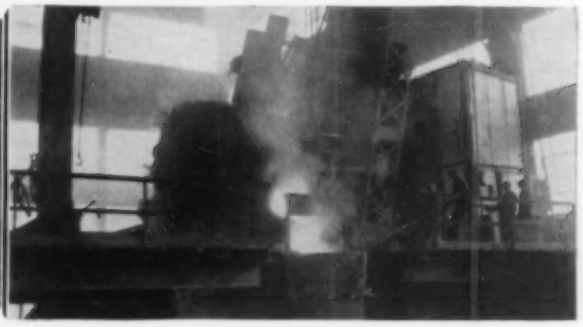
The Record of Awards

Navy Ordnance "E," October 24, 1941
All-Navy "E," April 24, 1942
First White Star, April 24, 1942
Army-Navy "E," October 24, 1942
Second White Star, October 24, 1942
Third White Star, April 24, 1943
Fourth White Star, October 24, 1943
Fifth White Star, October 24, 1944

NATIONAL FORGE
& ORDNANCE CO.
IRVINE, WARREN COUNTY, PENNA.
"WE MAKE OUR OWN STEEL"

For Excellence E *in Production*

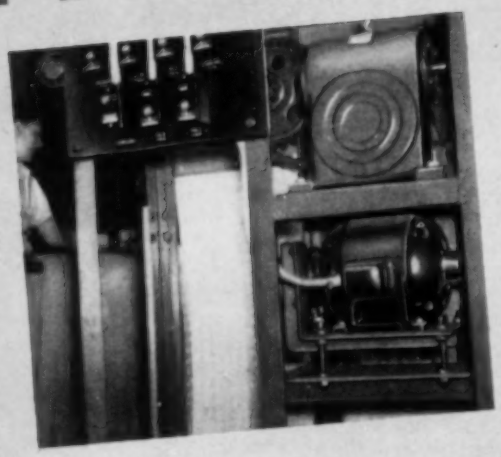
☆ ☆ ☆ ☆ ☆



IN STUFFY SPOTS

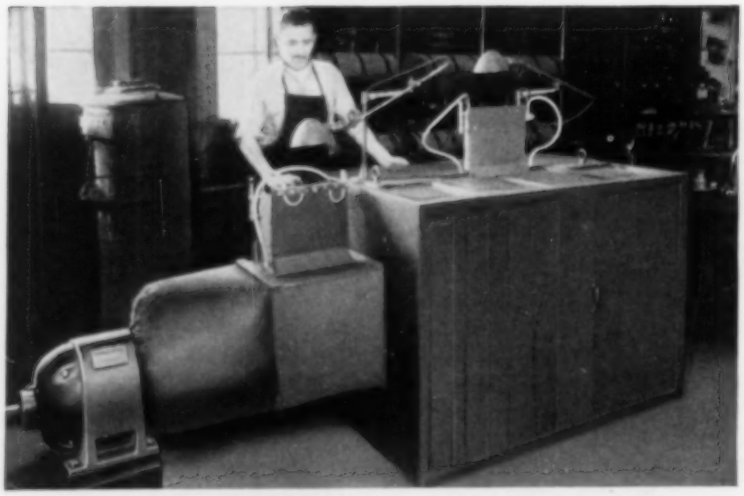
Many a motor must be located where walls, adjacent equipment, or materials cut down the free flow of air. Sometimes, as in the case of this wool-dryer drive, surroundings are hot, and stuffy, too.

Tri-Clad motors have proved themselves cool-running even under such conditions. Their powerful, double-end ventilating system moves the air at controlled velocity for effective heat removal. The location and baffling of dual exhaust ports discourage recirculation.



Tri-Clad motor drives conveyor on wool dryer—Bigelow Sanford Carpet Co., Amsterdam, N. Y.

AIR-FLOW TESTS OF TRI/CLAD MOTORS LEAD TO PROTECTION FROM OVERHEATING



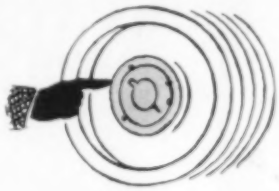
Plenum chamber test of Tri-Clad motor ventilation at G-E motor factory.

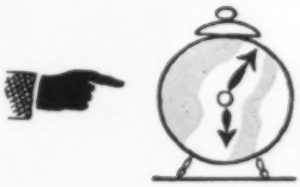
Before new types or sizes of Tri-Clad motors are approved for production, plenum chamber tests are conducted on the ventilating systems of sample models. These measurements serve as a check on previous calculations of the volume and velocity of air through the motor under different conditions. Other tests under load within enclosures and at abnormal ambient temperatures are also made. If your motors must be confined in stuffy spots, G.E. can help you make the right choice to beat the heat. *General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

TRI/CLAD MOTORS

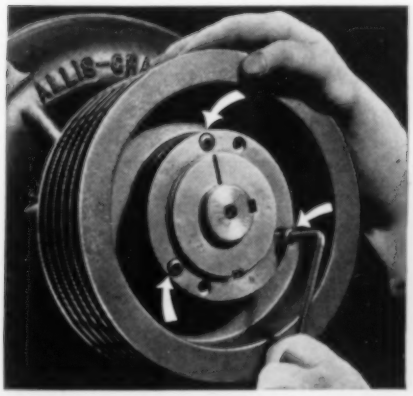
Buy all the BONDS you can—*and keep all you buy*

This  Saves:

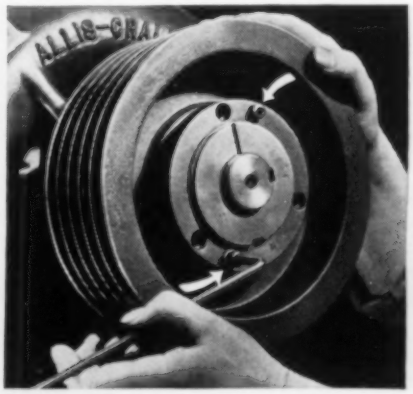


and

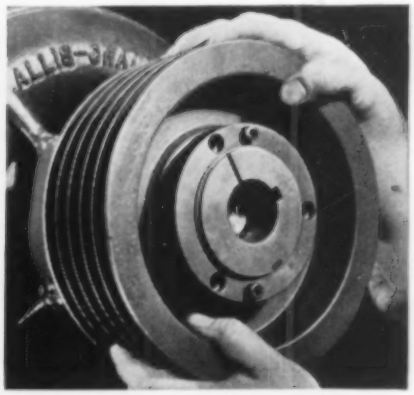
Yes, you save all three — time, money, trouble — with Allis-Chalmers' new "Magic-Grip" . . . *fastest mounting and demounting sheave on the market.* Three easy steps do it!



1 **Remove three capscrews** from bushing collar. A handy wrench — supplied with each sheave — is the only tool needed to remove Allis-Chalmers' new "Magic-Grip" from motor or machine shaft quickly and easily.



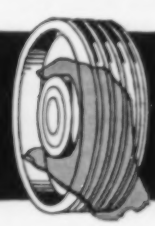
2 **Insert two capscrews** in tapped holes. As screws are turned, they become levers . . . automatically breaking tight grip of tapered split bushing on sheave and shaft. Entire unit is then ready for removal.

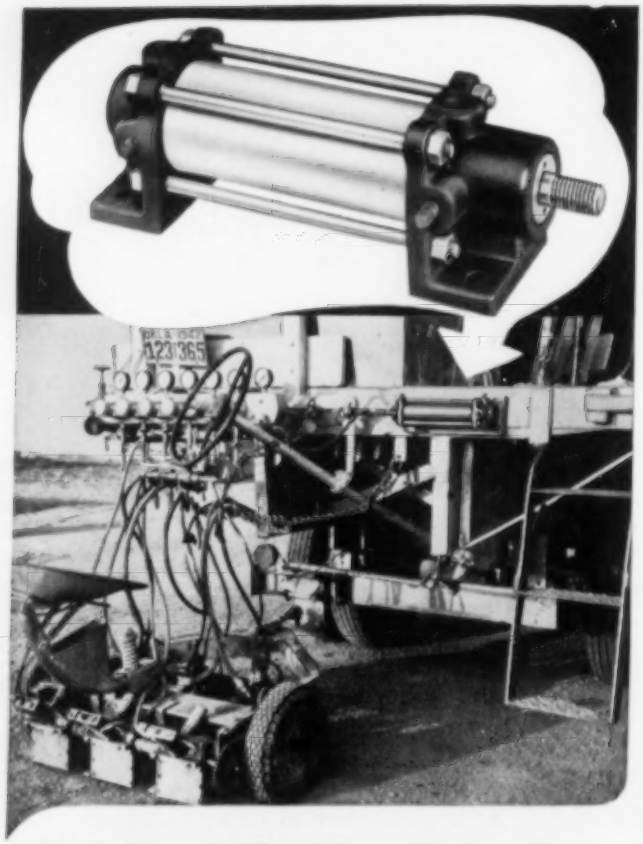


3 **Remove sheave from shaft.** Requires no mallet, no prying, no bulging muscles. You just slide the sheave off . . . smoothly, quickly. *It costs nothing extra!* Send for B6310. Allis-Chalmers, Milwaukee 1, Wis.

A 1760

Allis-Chalmers Texrope

"MAGIC-GRIP"  SHEAVES



K-C Road Marking Units Use NOPAK Air Cylinders!

This unusual application shows a NOPAK Air Cylinder, mounted on the rear of a motor truck. It emphasizes the fact that cylinder power can be employed successfully on any type of mobile equipment in which compressed air is available.

In this Kelly-Creswell road striping unit, a Standard NOPAK Model A Air Cylinder, controlled by a 3-way hand valve, performs an important lifting and lowering operation. The compressed air is supplied by the same compressor which supplies the spray guns and other air equipment embodied in this unit.

Whether employed on stationary or mobile equipment, NOPAK Cylinders of standard design can often provide vital pulling, pushing, lifting or clamping action to eliminate manual effort, speed-up the operating cycle, simplify control. Write for Bulletin 87.

. . . and

NOPAK Valves

are engineered for positive accurate control of air or hydraulic cylinders. Hand, Foot, and Solenoid Models in a complete range of sizes.

GALLAND-HENNING MFG. CO.
2759 S. 31st Street • Milwaukee 7, Wis.

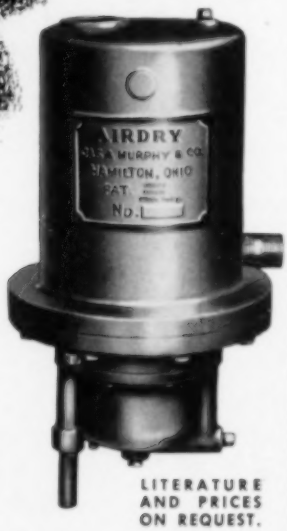
Representatives in Principal Cities

NOPAK VALVES and CYLINDERS
DESIGNED for AIR or HYDRAULIC SERVICE

A 4613-½R

THIS IS THE MURPHY TYPE A SEPARATOR
★
GUARANTEED

Pipe Sizes ⅛" to 4"
1 ½" to 4" Made in Steel



YES...

Guaranteed to remove all moisture from compressed air lines, and guaranteed against mechanical defects for a period of two years. Entirely mechanical and automatic. No absorbents or chemicals. No attention . . . No wear.

LITERATURE AND PRICES ON REQUEST.

Murphy *knows* compressed air. Write for our literature, or state your problem. Our engineers are at your service.

GUARANTEED COMPRESSED AIR PRODUCTS

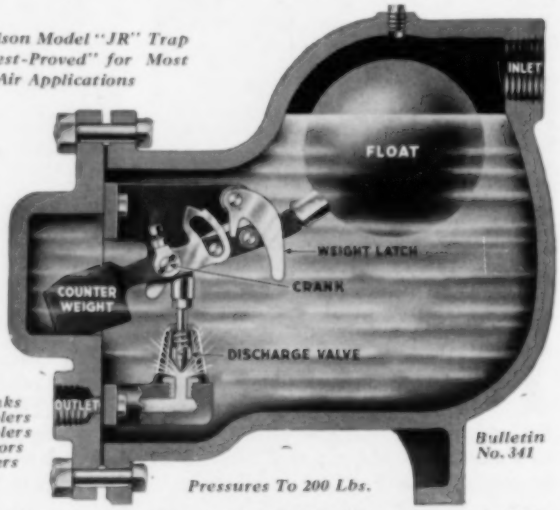
AFTERCOOLERS • SEPARATORS • STRAINERS • TRAPS
SPRAY GUNS • PISTOL SPRAYERS

JAS. A. MURPHY & CO.
HAMILTON, OHIO, U.S.A.
Moisture Elimination Up To 3000 Pounds Per Square Inch

NICHOLSON

America's Fastest-Acting
COMPRESSED-AIR TRAP

Nicholson Model "JR" Trap Is "Test-Proved" for Most Air Applications



For Air Tanks Intercoolers Aftercoolers Separators Receivers Etc.

Pressures To 200 Lbs.

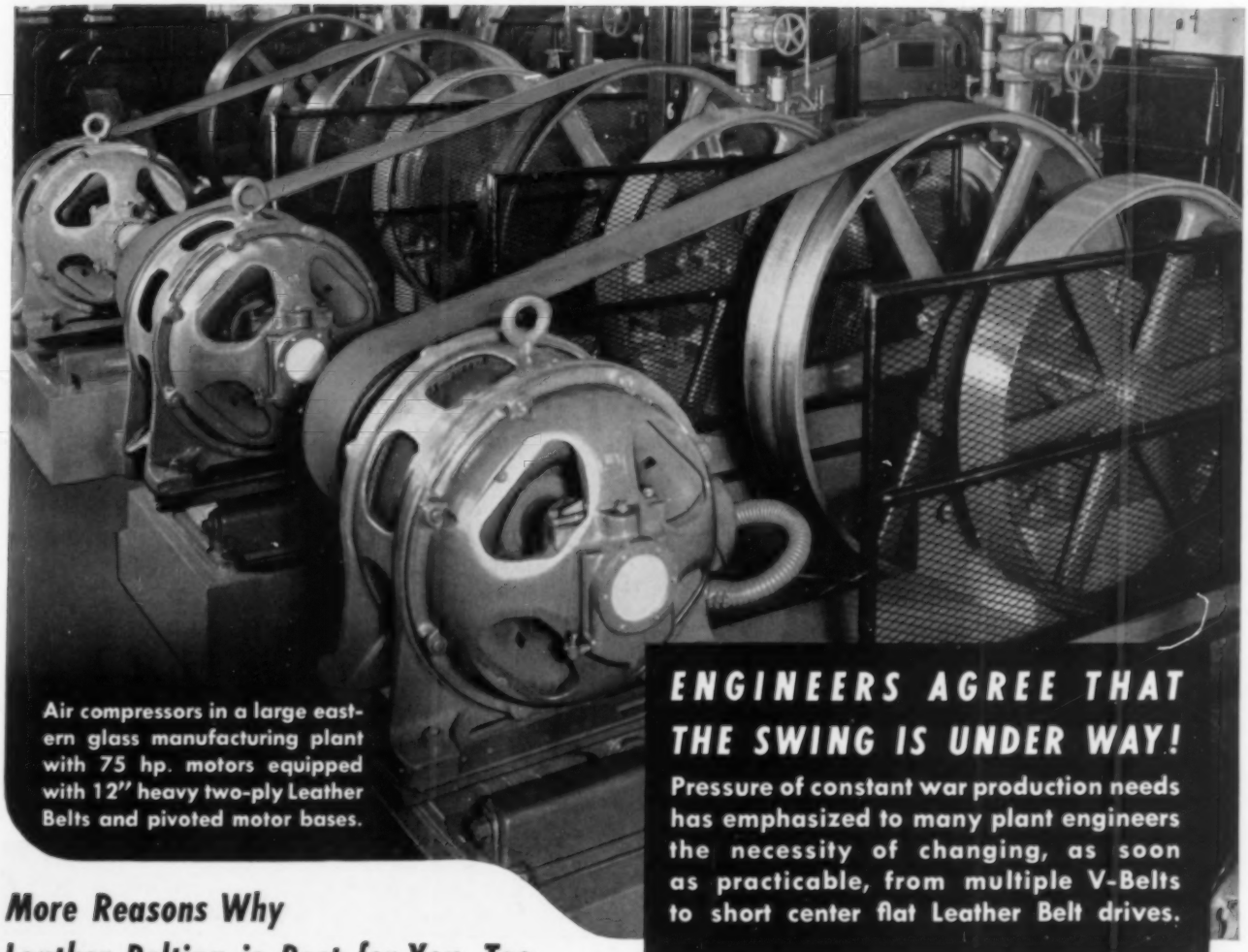
Bulletin No. 341

Due to their exclusive weight-operated design, Nicholson Model "JR" Compressed Air Traps open and close instantaneously, giving full, faster drainage of water and oil. Model "JR" has been a record-making trouble-shooter for hard-pushed warplant equipment. Send for details.

W. H. NICHOLSON & CO.
180 OREGON ST., WILKES-BARRE, PA.
Valves • Traps • Steam Specialties

ONLY *Leather Belting* CAN DO THIS JOB PROPERLY

"INDUSTRY LEARNS BEST FROM EXPERIENCE"



Air compressors in a large eastern glass manufacturing plant with 75 hp. motors equipped with 12" heavy two-ply Leather Belts and pivoted motor bases.

ENGINEERS AGREE THAT THE SWING IS UNDER WAY!

Pressure of constant war production needs has emphasized to many plant engineers the necessity of changing, as soon as practicable, from multiple V-Belts to short center flat Leather Belt drives.

More Reasons Why Leather Belting is Best for You, Too . . .

Plant operators are proving to their own satisfaction in many important cases that properly designed short center flat Leather Belt drives assure them longer belt life, less decrease in compressor capacity due to belt slip — and greater overload capacity than is possible with any other belt design or material. This is true because of the unique characteristics of Leather Belting in which the co-efficient of friction increases with the increased load, while its shock absorbing qualities protect the motor and compressor bearings.

YOU'LL HAVE FEWER SHUTDOWNS IF YOU STANDARDIZE ON SHORT CENTER FLAT LEATHER BELT DRIVES

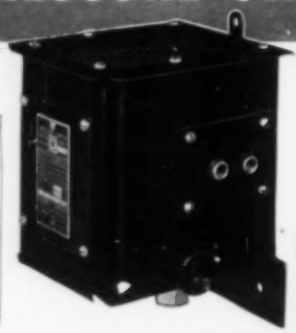
AMERICAN LEATHER BELTING ASSOCIATION • 41 Park Row, NEW YORK 7, N.Y.

Marine PRESSURE SWITCHES

DRIPPROOF AND WATERTIGHT HIGH SHOCK CONTACT BLOCK— TWO OR THREE POLE—CLASS 9013 TYPE AW-H, MW-H, LW-H

ELECTRICAL RATINGS

Voltage	Single Phase A.C.	Polyphase A.C.	D.C.
110V.	2 H.P.	3 H.P.	1 H.P.
220V.	3 H.P.	5 H.P.	1 H.P.
440-550	5 H.P.	5 H.P.	.....
32V.	.....	.....	½ H.P.



● Built for Marine Service to conform with requirements for dripproof and watertight devices of shockproof construction. The switches differ from standard in the use of a special sheet steel enclosure and drip hood with gasket seal and a special high shock bakelite contact block in two or three pole form. The three types AW-H, MW-H and LW-H represent three diaphragm sizes and three range and differential variations. A release valve for air compressor service may be added to any of the types, as illustrated. Write for Bulletin 562.

REGULATOR DIVISION

SQUARE D COMPANY

DETROIT • MICHIGAN

New Model A-1 *Pur-O-fier*

For Compressed Air

Positive purification of air lines is assured with this new Model A-1 Pur-O-fier designed to eliminate free moisture, oil and foreign matter in small compressed air systems. It operates with from 1 to 5 cubic feet of air and for intermittent operations is extremely sensitive to the slightest movement of air. Weighing only 1¼ lbs., this new unit is just 3⅛" in diameter by 5 5/16" deep including plastic, transparent entrainment sump. Model A-1 Pur-O-fier requires no maintenance.

Drain valve permits easy and quick draining of the sump. Pur-O-fier uses positive, centrifugal action as a medium for purification and can be used for air-operated instrument controls, air-operated gauges of the precision and checking type, and air-operated cleaning devices of many types. This unit will operate effectively from 1 to 75 P.S.I. Write for bulletin No. 11 giving complete details.

Patent applied for

Write for New Bulletin No. 11 giving complete specifications and applications

BIRD-WHITE COMPANY
Dept. CA, 3119 W. Lake Street
CHICAGO, ILLINOIS

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this is NO TIME FOR A TRIAL BALLOON

There's no need to buy pencils of undetermined origin when you can use the pencils that have already made their mark.

For many years, the KOH-I-NOOR Pencil Factory has been producing pencils uniformly graded in smoothly finished straight grained cedar.

TRY A KOH-I-NOOR TODAY
THERE ARE NO "STRINGS" ATTACHED

Send for Leaflet No. 19.

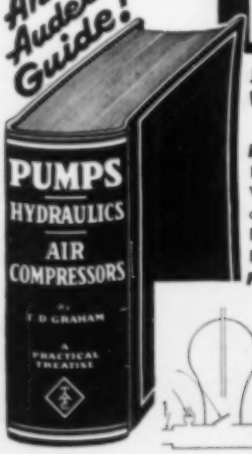
KOH-I-NOOR

The RIGHT pencil for the RIGHT job

KOH-I-NOOR PENCIL COMPANY, INC., BLOOMSBURY, NEW JERSEY

PUMPS-HYDRAULICS-AIR COMPRESSORS

An Audel Guide!



JUST OUT! 3 BOOKS IN ONE—OVER 1650 PAGES, 1654 ILLUSTRATIONS, WITH QUESTIONS AND ANSWERS. COMPLETE PRACTICAL CONCISE INFORMATION FOR ALL ENGINEERS AND OPERATORS.

***PART 1*—PUMPS—850 Pages:** All types—Centrifugal—Rotary—Reciprocating Pumps: Their Theory, Construction, Operation and Calculations. Air and Vacuum Chambers—Power Pumps—Air Pumps—Jet Condensers—Surface Condensers—Condenser Auxiliaries—Condenser Operation—Calculations—Cooling Ponds—Cooling Towers—Water Supply—Hydraulic Rams—Special Service Pumps—Automotive Fire Pumps—Dredges—Codes. 942 Illustrations.

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Free Examination

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$4 COMPLETE PAY ONLY $1 A MO.

AUDEL, Publishers, 49 West 23 St., New York 10, N. Y.
Send postpaid AUDELS PUMPS, HYDRAULICS, AIR COMPRESSORS ($4). If I decide to keep it, I will send you $1 within 7 days; then remit $1 monthly until purchase price of $4 is paid. Otherwise, I will return it promptly.

Name.....

Address.....

Occupation.....

Employed by..... P11

. . . cubic feet per minute

Let's imagine a stream of air cubes caught within some strong force that is squeezing them from their one-cubic-foot size down to smaller and smaller cubes . . . increasing the pressure within them . . . pushing them into a pipe . . . creating compressed-air power. Cube after cube flows on as we count *cubic feet per minute* . . . in short we say *cfm*.

Emerging somewhere from the end of a distribution pipe these compressed cubes are expanding . . . exerting compressed-air power, doing work. Finally, the cubes regain their original size and pressure . . . again become free atmosphere. Once more we count them . . . so many *cfm*.

Machines that squeeze or compress the air are called *air compressors*. Machines that use the compressed air to push a piston, or turn a wheel, are called *air tools* . . . drills, hammers, wrenches, hoists, and grinders. *Cfm* is the "yardstick" for measuring both the capacity of compressors and the air consumption of air tools.

But *cfm* is only one means of appraising these machines. On countless compressors and air tools, widely used throughout the world, both in peacetime and in war, you will find the IR trademark. This symbol stands for nearly 75 years of pioneering and development in the compressed-air industry. It is your assurance of a reliable machine that will economically produce or apply compressed-air power.

Air for power purposes is usually compressed to 100 pounds pressure in machines varying in size from 2 to 16,000 cfm, requiring from ½ to 3000 horsepower. But there are hundreds of other uses for compressors.

One example is a 2500-horsepower I-R compressor that inhales about 3600 cfm (a box-car full every minute) of nitrogen and hydrogen gas, squeezing the gas in seven steps to one-thousandth of its original size . . . increasing its pressure to 15,000 pounds . . . an important step in producing synthetic ammonia needed in the manufacture of explosives and fertilizers.

Consider also machines like a 15,000-horsepower I-R Turbo-Blower in a steel plant . . . compressing 125,000 cfm of air to 30 pounds for combustion in the blast furnaces.

Ingersoll-Rand

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COMPRESSORS • TURBO-BLOWERS • ROCK DRILLS • AIR TOOLS • CENTRIFUGAL PUMPS • CONDENSERS • OIL AND GAS ENGINES

BUILT TO TAKE IT!

Norgren Synthetic Hose Assemblies are built of the finest material and constructed to take it; from heat, cold, solvents and vibration.

Meet the full requirements for high and low, hydraulic or pneumatic pressure lines. Permanent machined couplings for high pressures and re-usable couplings for low pressures. Available, with male or union couplings, in a range of sizes, any length.

Send your inquiry, including I. D., length of hose and thread requirements, to C. A. Norgren Co., 220 Santa Fe Dr., Denver 9, Colorado.

Limber as a Lariat
STRONG as STEEL

Norgren

R. C. PILOT VALVES FOR POSITIVE CONTROL

R-C Unloader Pilot Valves (plain or strainer type) are standard on many leading compressors . . . installed as replacements on thousands of compressors in all parts of the U. S. A. and overseas. The R-C valve—positive in action—cannot chatter . . . it's always in open or closed position. Adjustment is provided for any unload-to-load range from 3% to 30% of maximum receiver pressure. Install an R-C Unloader Pilot valve—let performance prove its value. Specify air pressure and range of on-and-off operation desired. Write for price and recommendation.

R. C. PILOT VALVE
STRAINER TYPE

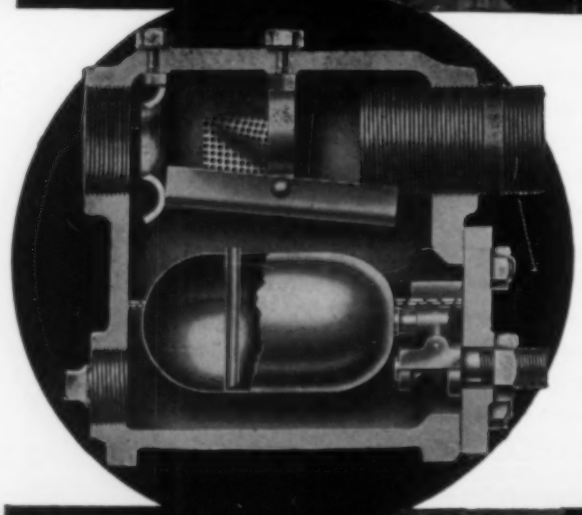
R. CONRADER CO.

1207 FRENCH STREET - ERIE, PA.

PILOT VALVES for Portable and Stationary Air Compressors provided with Unloaders

DRI AIR MAY BE INSTALLED BY SUSPENDING IT FROM THE PIPING WITHOUT ANY OTHER SUPPORT.

INCREASED PNEUMATIC EFFICIENCY WITH THIS AUTOMATIC SEPARATOR



PROTECT EQUIPMENT WITH

DRIAIR

SEPARATES • COLLECTS • DELIVERS

• DriAir separates and automatically ejects the condensed water and oil from compressed air lines, collects pipe scale and rust, delivers clean dry air to tools and other pneumatic equipment. This promotes better lubrication, reduces wear, increases life of tools and produces greater output. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent.

A TYPICAL INSTALLATION SHOWING DRI AIR STANDING ON A CONCRETE FLOOR NEXT TO THE WALL.

WRITE FOR BULLETIN DA WHICH FULLY DESCRIBES THE CONSTRUCTION AND OPERATION OF THE DRIAIR.

NEW JERSEY METER CO.

"SPECIALISTS IN COMPRESSED AIR DEVICES"

PLAINFIELD, NEW JERSEY

INGERSOLL - RAND "Power Houses on Wheels" USE TIMKEN BEARINGS

Ingersoll-Rand Portable Air Compressors equipped with Timken Bearings supplying power to Ingersoll-Rand Wagon Drills—also Timken Bearing Equipped.

Ingersoll-Rand Portable Air Compressors are equipped with Timken Tapered Roller Bearings on the compressor crank shafts and also in the road wheels; this helps to get them to the job quicker and to keep them on the job longer.

A Timken Bearing Equipped compressor is the ideal anti-frictionized compressor because Timken Bearings provide anti-friction advantages *in full;* these advantages comprise elimination of friction; protection against radial, thrust and combined loads; maintenance of moving parts in correct and constant alignment. They assure constant operating smoothness; greater endurance and longer compressor life. Make sure you have them in your new compressors — portable or stationary. The Timken Roller Bearing Company, Canton 6, Ohio.

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

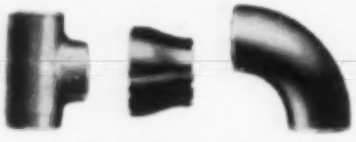
WALWORTH

Pipe Fittings

A complete line of standardized types in

STEEL
in series 150 to 1500

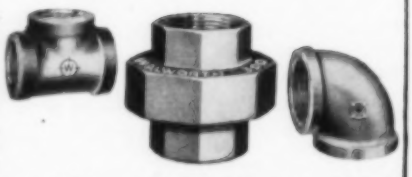
Cast Steel Fittings



Steel Welding Fittings

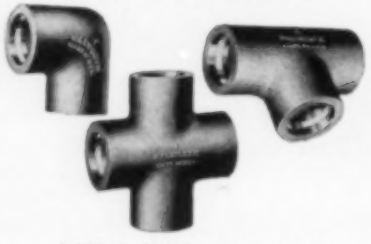
Forged Steel Flanges

BRONZE



125 Lb and 250 Lb, Screwed ends

150 Lb and 300 Lb Walseal ends

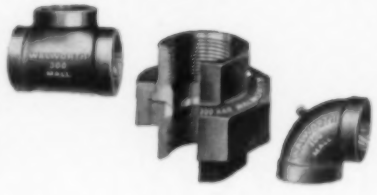


3,000 Lb O.W.G., Walseal ends

IRON

125 Lb and 250 Lb Cast Iron

150 Lb Malleable Iron



300 Lb Malleable Iron

Walworth's comprehensive line of pipe fittings is made in a wide range of types and sizes to meet every piping requirement. A few of the many regular Walworth fittings are illustrated above. All Walworth fittings are made to the highest standards of quality, both as to dimensional accuracy and metallurgical properties. In design, construction, and performance, they reflect Walworth's 103 years' experience in the manufacture of quality valves and fittings.

For detailed information on Walworth's complete line of valves, fittings, and pipe wrenches, see your local Walworth distributor or write for a free copy of Catalog 42.

12 AWARDS
TO 4 PLANTS

WALWORTH
valves AND fittings
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LABORATORY CONTROL

To assure strict adherence to specifications, sample test bars of the metals from which Walworth Pipe Fittings are made are subjected to regular testing in Walworth laboratories. These and other regular controls and inspections assure the high quality of all Walworth Pipe Fittings. The illustration shows a test on a cast iron transverse bar.

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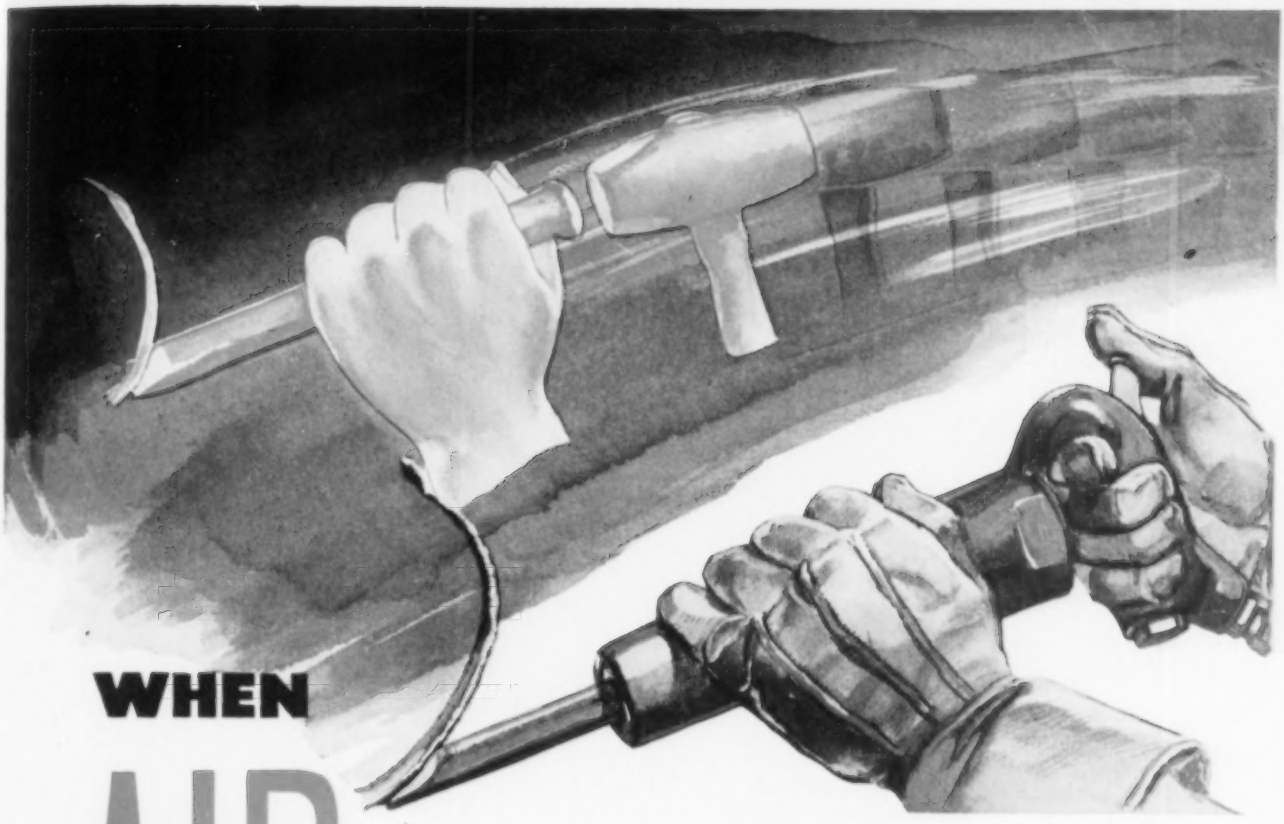

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Years of continual research and improvement have enabled us to produce many types and sizes of hand-held air tools. In addition to air hammers for chipping, scaling, riveting, digging, tamping, etc., we have a complete line of air drills, reamers, wrenches, grinders, etc. They are all favorites. When you buy an I-R air tool you get one that is powerful, durable, safe, and easy to hold.

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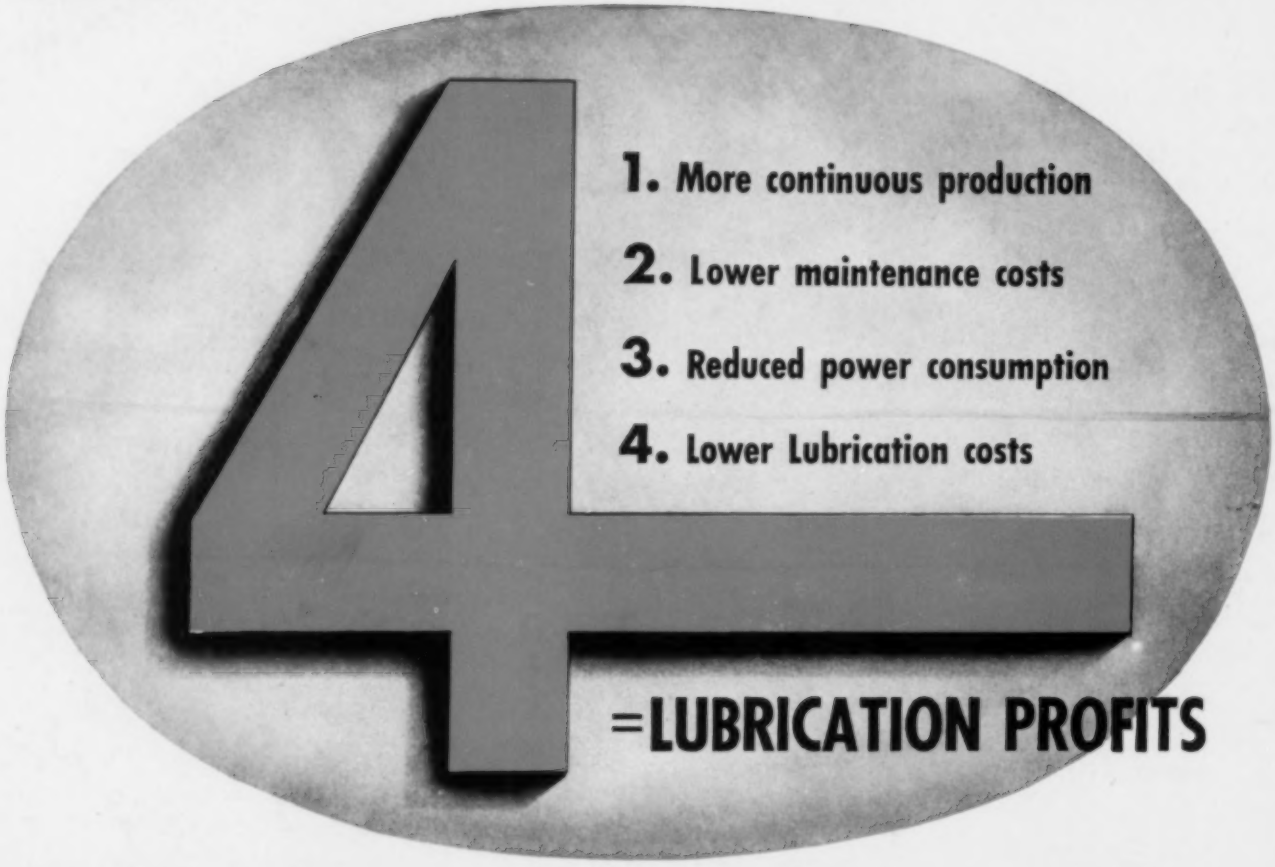

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